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Attorney Docket No. SIC-04-013

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of: KOJI UNO Application No.: 10/711,560 Filed: September 24, 2004 For: APPARATUS FOR PROVIDING ELECTRICAL SIGNALS TO BICYCLE COMPONENTS	Examiner: Pedro J. Cuevas Art Unit: 2834 APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

This is an appeal brief for the above-captioned matter.

I. Real Party In Interest

The assignee and real party in interest is Shimano, Inc., a Japanese corporation having a principal place of business in Osaka, Japan.

II. Related Appeals And Interferences

There are no prior or pending appeals, interferences or judicial proceedings known to the appellant, to appellant's legal representative, or to the assignee which may be related to, directly affect, or be directly affected by, or have a bearing on the Board's decision in the pending appeal.

III. Status Of Claims

Claims 1-13 and 17-44 are pending under final rejection and are under appeal.

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IV. Status Of Amendments

No amendment was filed subsequent to final rejection.

V. Summary Of Claimed Subject Matter

The application discloses several embodiments of an apparatus for providing electrical signals to bicycle components. Cited reference numbers and text are examples only and are not intended to be limiting. Line numbers refer to the line numbers within each individually cited paragraph. The embodiment shown in Fig. 9 is cumulative and will not be discussed in detail.

As applied to independent claim 1, an apparatus for providing electrical signals to bicycle components comprises:

a housing ((32), Fig. 4, page 4, paragraph [0017], lines 5-7; (132), Fig. 6, paragraph [0025], lines 4-6; (232), Fig. 8, paragraph [0034], lines 4-6) adapted to be mounted to the bicycle;

a regulator ((42), Fig. 3, page 4, paragraph [0018], lines 1-2; (142), Fig. 5, page 7, paragraph [0027], lines 1-2; (242), Fig. 7, page 10, paragraph [0037], lines 1-2) supported by the housing (32, 132, 232) to receive signals from a power supply ((19, 41), Fig. 3, page 4, paragraph [0018], lines 8-9; (19, 141), Fig. 5, page 7, paragraph [0027], lines 8-9; (19, 241) Fig. 7, page 10, paragraph [0037], lines 8-9); and

an output ((34), Fig. 4, page 4, paragraph [0017], lines 5-7; (134), Fig. 6, page 6, paragraph [0025], lines 4-6; (234), Fig. 8, page 9, paragraph [0034], lines 4-6) disposed on the housing (32, 132, 232) to supply regulated signals provided by the regulator (42, 142, 242) to a plurality of electrical bicycle components ((50), Fig, 4, page 4, paragraph [0019], lines 1-2; (150), Fig, 6, page 6, paragraph [0025], lines 1-3; (250), Fig, 8, pages 9-10, paragraph [0035], lines 2-4) external to the housing (32, 132, 232);

wherein the output (34, 134, 234) includes:

a first external terminal (e.g., one of (34a-34d), Fig. 4, page 4, paragraph [0017], lines 8-11; one of (136a-136d), Fig. 6, page 7, paragraph [0026], lines 3-7; one of (238a, 238b, 239), Fig. 8, page 10, paragraph [0036], lines 1-7) to provide non-ground electrical signals (e.g., one of 1.2 V, 3.0V, 3.5 V, or 3.7 V, pages 4-5, paragraph [0019], lines 11-14; one of

1.2 V, 3.0V, 3.5 V, or 3.7 V, pages 7-8, paragraph [0028], lines 10-13; one of 1.2 V, 3.5 V, or 3.7 V, pages 10-11, paragraph [0038], lines 9-12) to a first electrical bicycle component (e.g., one of (51-54), Fig. 4, page 4, paragraph [0019], lines 2-4; one of (151-154), Fig. 6, page 6, paragraph [0025], lines 3-4; one of (251,253, 254), Fig. 8, page 9, paragraph [0034], lines 3-4, all of which are positive voltages); and

a separate second external terminal (e.g., another one of (34a-34d), Fig. 4, page 4, paragraph [0017], lines 8-11; another one of (136a-136d), Fig. 6, page 7, paragraph [0026], lines 3-7; another one of (238a,238b, 239), Fig. 8, page 10, paragraph [0036], lines 1-7) to provide separate non-ground electrical signals (e.g., a different one of 1.2 V, 3.0V, 3.5 V, or 3.7 V, pages 4-5, paragraph [0019], lines 11-14; a different one of 1.2 V, 3.0V, 3.5 V, or 3.7 V, pages 7-8, paragraph [0028], lines 10-13; a different one of 1.2 V, 3.5 V, or 3.7 V, pages 10-11, paragraph [0038], lines 9-12) to a second electrical bicycle component (e.g., another one of (51-54), Fig. 4, page 4, paragraph [0019], lines 2-4; another one of (151-154), Fig. 6, page 6, paragraph [0025], lines 3-4; another one of (251, 253, 254), Fig. 8, page 9, paragraph [0034], lines 3-4).

As applied to independent claim 26, an apparatus for providing electrical signals to bicycle components comprises:

a housing ((32), Fig. 4, page 4, paragraph [0017], lines 5-7; (132), Fig. 6, paragraph [0025], lines 4-6; (232), Fig. 8, paragraph [0034], lines 4-6) adapted to be mounted to the bicycle;

a voltage regulator ((42), Fig. 3, page 4, paragraph [0018], lines 1-2; (142), Fig. 5, page 7, paragraph [0027], lines 1-2; (242), Fig. 7, page 10, paragraph [0037], lines 1-2) supported by the housing (32, 132, 232) to receive power from a power supply ((19, 41), Fig. 3, page 4, paragraph [0018], lines 8-9; (19, 141), Fig. 5, page 7, paragraph [0027], lines 8-9; (19, 241) Fig. 7, page 10, paragraph [0037], lines 8-9) and to provide first and second different non-ground voltages (pages 4-5, paragraph [0019], lines 11-14; pages 7-8, paragraph [0028], lines 10-13; pages 10-11, paragraph [0038], lines 9-12), each of which is adapted to power respective first and second electrical bicycle components (e.g., two of (51-54), Fig. 4, page 4, paragraph [0019], lines 2-4; two of (151-154), Fig. 6, page 6, paragraph [0025], lines 3-4; two of (251,253, 254), Fig. 8, page 9, paragraph [0034], lines 3-4); and

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first and second external output terminals (e.g., two of (34a-34d), Fig. 4, page 4, paragraph [0017], lines 8-11; two of (136a-136d), Fig. 6, page 7, paragraph [0026], lines 3-7; two of (238a, 238b, 239), Fig. 8, page 10, paragraph [0036], lines 1-7) disposed on the housing to supply the respective first and second different non-ground voltages from the regulator (42, 142, 242) to the respective first and second electrical bicycle components (51-54, 151-154, 251, 253, 254) external to the housing (32, 132, 232).

As applied to independent claim 27, an apparatus for providing electrical signals to bicycle components comprises:

a housing ((232), Fig. 8, paragraph [0034], lines 4-6) adapted to be mounted to the bicycle;

a regulator ((242), Fig. 7, page 10, paragraph [0037], lines 1-2) supported by the housing (232) to receive signals from a signal source ((19, 241) Fig. 7, page 10, paragraph [0037], lines 8-9);

a plurality of mounting members ((236a-236c), Fig. 8, page 9-10, paragraph [0035], lines 2-7) disposed on the housing (232) to directly attach a corresponding plurality of electrical bicycle components ((251,253, 254), Fig. 8, page 9, paragraph [0034], lines 3-4) to the housing (232); and

an external output terminal ((238, 238b, 239), Fig. 8, page 10, paragraph [0036], lines 1-7) disposed on the housing (232) in close proximity to each mounting member (236a-236c) to supply regulated non-ground signals (pages 10-11, paragraph [0038], lines 9-12) provided by the regulator (242) to corresponding ones of the plurality of electrical bicycle components (251,253, 254) mounted to the plurality of mounting members (236a-236c).

As applied to independent claim 28, an apparatus for providing electrical signals to bicycle components comprises:

a housing ((132), Fig. 6, paragraph [0025], lines 4-6) adapted to be mounted to the bicycle;

a regulator ((142), Fig. 5, page 7, paragraph [0027], lines 1-2) supported by the housing (132) to receive signals from a signal source ((19, 141), Fig. 5, page 7, paragraph [0027], lines 8-9);

a mounting member ((132a), Fig. 6, page 6, paragraph [0025], lines 6-8) adapted to directly mount each one of a plurality of electrical bicycle components (151-154) to that mounting member (132a), each electrical bicycle component (151-154) having different non-ground signal requirements (page 8, paragraph [0030], lines 1-2); and

an external output terminal ((136a-136d), Fig. 6, page 7, paragraph [0026], lines 3-7) disposed on the housing to supply regulated non-ground signals (pages 7-8, paragraph [0028], lines 10-13) provided by the regulator (142) to each of the plurality of electrical bicycle components (151-154) when individually mounted to the mounting member (page 8, paragraph [0030], lines 11-17).

VI. Grounds Of Rejection To Be Reviewed On Appeal

Claims 2, 12, 18, and 33 stand rejected under 35 U.S.C. §112 as not complying with the enablement requirement.

Claims 1-9, 11-13, and 18-44 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kitamura (US 6,418,041 B1) in view of Copeland (US 5,015,918).

Claims 10 and 17 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kitamura (US 6,418,041 B1) and Copeland (US 5,015,918) in view of Murashige, et al (US 2004/0013938).

VII. Arguments

Rejection under 35 U.S.C. §112

Claim 2

Page 4 of the final office action dated October 17, 2007 states that it is not clear how a power communication path connected to an external terminal or connector can alter or modify the physical characteristics of an electric signal generated by the regulator. That is not what is recited in claim 2. Claim 2 recites "wherein a first power communication path connected to the first external terminal provides a physically different power characteristic from the regulator than a second power communication path connected to the second external terminal." Claim 2 is not directed to modification of signals by the power communication paths. The plurality of power communication paths merely carry signals with physically different (as opposed to conceptually different) power characteristics arising from the regulator. This feature is enabled by the specification at pages 4-5,

paragraph [0019], lines 1-14; pages 7-8, paragraph [0028], lines 1-13; and pages 10-11, paragraph [0038], lines 1-12.

Claims 12 and 18

Claims 12 and 18 recite "wherein the first external terminal and the second external terminal provide different physical power characteristics from the regulator relative to each other." Claims 12 and 18 are not directed to modification of signals by the terminals. The first and second external terminals merely provide signals with physically different (as opposed to conceptually different) power characteristics arising from the regulator. This feature is enabled by the specification at pages 4-5, paragraph [0019], lines 1-14; pages 7-8, paragraph [0028], lines 1-13; and pages 10-11, paragraph [0038], lines 1-12.

Claim 33

Claim 33 recites "wherein the non-ground electrical signals provided from the regulator by the first external terminal are different from the non-ground electrical signals provided from the regulator by the second external terminal." Claim 33 is not directed to modification of signals by the terminals. The first and second external terminals merely provide different signals arising from the regulator. This feature is enabled by the specification at pages 4-5, paragraph [0019], lines 1-14; pages 7-8, paragraph [0028], lines 1-13; and pages 10-11, paragraph [0038], lines 1-12.

Rejection under 35 U.S.C. §103(a) over Kitamura in view of Copeland

Claims 1, 32, and 34

Claim 1 recites a housing adapted to be mounted to the bicycle, and a regulator supported by the housing to receive signals from a power supply. The final office action refers to Kitamura's control panel (20) as a housing and refers to Kitamura's voltage regulator (43) as the recited regulator. However, as shown in Fig. 5 of Kitamura, voltage regulator (43) is part of power supply (27) which, as stated at column 4, lines 47-51, is housed within control box (31) mounted to the middle of the bicycle as shown in Fig. 2. Thus, given the interpretation in the office action, voltage regulator (43) is not supported by Kitamura's control panel (housing) (20) as required by claim 1,

and voltage regulator (43) is not disposed within Kitamura's control panel (housing) (20) as required by claim 32.

Claim 1 also recites an output disposed on the housing. Kitamura's outputs (44, 45) are not disposed on housing (20) as alleged in the office action. As shown in Kitamura's Fig. 6, outputs (44, 45) are part of power supply (27) which, as noted above, is housed within control box (31), not in control panel (housing) (20).

Copeland discloses a removable headlamp unit (17) wherein a voltage regulator (6) provides regulated voltage to a headlight bulb (1) disposed within headlamp unit (17). The regulated voltage is not provided to anything outside of headlamp unit (17). Only unregulated battery voltage is supplied to terminals (23) and (24). Thus, like Kitamura, Copeland also fails to disclose an output disposed on a housing to supply regulated signals to a plurality of bicycle electrical components external to the housing. Even if the teachings of Copeland were applied to Kitamura, the result would not be the claimed invention. The result would be a system wherein regulated voltage is supplied to internal components, such as Kitamura's corresponding headlamp (18a, 18b, Fig. 1) mounted to front fork (3).

Claim 1 also recites separate first and second external terminals, wherein the first external terminal provides non-ground electrical signals to a first electrical bicycle component, and wherein the separate second external terminal provides separate non-ground electrical signals to a second electrical bicycle component. Kitamura provides a single non-ground signal at terminal (44), and the same is true for Copeland's regulator circuit (6). Thus, neither Kitamura nor Copeland discloses or suggests the subject matter presently claimed.

The statement at page 2, paragraph 3, of the office action that one cannot attack references individually does not apply to the present situation. When an office action alleges that a reference discloses a particular feature, it is entirely proper to show how that reference does not show that feature. Also, it is entirely proper to point out that *none* of the references discloses or suggests a particular element.

Finally, when discussing the location of the outputs on the housing at paragraph 5 bridging pages 2-3, the office action cites *In re Japikse* for the proposition that rearranging parts of an invention involves only routine skill in the art. However, that reasoning is an example of the application of a *per se* rule of obviousness that "is legally incorrect and must cease." In re Ochiai 71 F.3d 1565, 1572; 37 USPQ.2d 1127, 1133 (Fed.Cir. 1995). *See, also,* Ex Parte Granneman, 68 USPQ.2d 1219 (BdPatApp&Int 2003) (Unpublished). The office action did not compare the facts in *Japikse* with those in the present case and explain why, based upon this comparison, the legal conclusion in the present case should be the same as that in *Japikse*.

Claim 2

Kitamura fails to disclose a plurality of power communication paths that provide signals with physically different (as opposed to conceptually different) power characteristics to shift controller (9) and lamp controller (10a) as required by claim 2. In fact, the same power signal is provided to both components from regulator (43), albeit through different switches. Also, it cannot be said that the power signals provided to Kitamura's shift controller (9) and lamp controller (10a) inherently have physically different power characteristics. A claim limitation is inherent in the prior art if it is *necessarily* present in the prior art, not merely probably or possibly present. *Rosco v. Mirror Lite,* 304 F.3d 1373, 1380; 64 USPQ2d 1676 (Fed.Cir. 2002).

Claims 3-4

Claim 3 recites an input disposed on the housing to receive power from an external power supply and to supply the power from the external power supply to the regulator. Insofar as Kitamura's control panel (20) is interpreted to be the housing, then, as shown in Kitamura's Fig. 4, control panel (20) does not have any input to receive power from an external power supply and to also supply the power from the external power supply to a regulator.

Claim 5

Claim 5 recites a power storage element supported by the housing for storing power from the alternating current generator. As shown in Kitamura's Fig. 4, no power storage element is supported by control panel (housing) (20).

Claim 6

Claim 6 recites that the plurality of electrical bicycle components comprise a radio, a cell phone charger and a light. Kitamura's components do not include a radio or a cell phone charger as required by claim 6.

Page 3 of the office action states that if a prior art structure is capable of performing an intended use, then it meets the claim. However, Kitamura's structure does not have the capability of providing signals to a radio or a cell phone charger , let alone all three components as required by claim 3.

Claim 7

Claim 7 recites that at least one of the first external terminal or the second external terminal is structured to be detachably connected to its corresponding first or second electrical bicycle component. The definition of "detachable" is "designed to come apart." Nothing on Kitamura's control panel (housing) (20) is designed to detachably connect any other component.

Claim 8

Claim 8 recites a mounting member disposed on the housing to detachably mount at least one of the first or second electrical bicycle components externally to the housing so that the at least one of the first or second electrical bicycle components is carried by the housing and electrical signals are provided from the at least one of the first external terminal or the second external terminal to the at least one of the first or second electrical bicycle components. Kitamura discloses no such mounting member.

Furthermore, the definition of "detachable" is "designed to come apart." Nothing on Kitamura's control panel (housing) (20) is designed to detachably connect any other component, and especially not such that the at least one of the first or second electrical bicycle components is carried by the housing and electrical signals are provided from the at least one of the first external terminal or the second external terminal to the at least one of the first or second electrical bicycle components.

Finally, page 3 of the office action alleges that mounting members for mounting components to a bicycle frame are common. That may be, but that is not what claim 8 recites. Claim 8 recites "a mounting member disposed on the housing to detachably mount at least one of the first or second electrical bicycle components externally to the housing so that the at least one of the first or second electrical bicycle components is carried by the housing." Thus, claim 8 is directed to mounting electrical components to the housing, not to the mere mounting of the entire apparatus to the bicycle frame.

Claim 9

Claim 9 recites wherein the at least one of the first external terminal or the second external terminal comprises a contact terminal structured to contact a complementary contact terminal on its corresponding first or second electrical bicycle component when the corresponding first or second electrical bicycle component is mounted to the housing. Copeland discloses external contact terminals (43, 44), but no reasoning was provided as to why one of ordinary skill would want to put such terminals on Kitamura's housing (20) to electrically connect a bicycle component. A claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR International Co. v. Teleflex Inc.* 550 U.S. __, 82 USPQ2d 1385, 1396 (2007). No reasoning was provided as to why one of ordinary skill in the art would want to apply the teachings of Copeland to Kitamura in a manner relevant to claim 9.

Claims 11 and 29

Claims 11 and 29 recite that each of first and second external terminals is structured to be detachably connected to its corresponding first or second electrical bicycle component. The

definition of "detachable" is "designed to come apart." Nothing on Kitamura's control panel (housing) (20) is designed to detachably connect any other component.

Claims 12 and 18

Kitamura fails to disclose first and second external terminals that provide signals with physically different (as opposed to conceptually different) power characteristics to shift controller (9) and lamp controller (10a) as required by claims 12 and 18. In fact, the same power signal is provided to both components from regulator (43), albeit through different switches. Also, it cannot be said that the power signals provided to Kitamura's shift controller (9) and lamp controller (10a) inherently have physically different power characteristics. A claim limitation is inherent in the prior art if it is *necessarily* present in the prior art, not merely probably or possibly present. *Rosco v. Mirror Lite*, 304 F.3d 1373, 1380; 64 USPQ2d 1676 (Fed.Cir. 2002).

Claim 13

Claim 13 recites first and second mounting members disposed on the housing and structured to detachably mount a first or second electrical bicycle component to the housing. Kitamura discloses no such mounting members.

Furthermore, the definition of "detachable" is "designed to come apart." Nothing on Kitamura's control panel (housing) (20) is designed to detachably connect any other component.

Finally, page 3 of the office action alleges that mounting members for mounting components to a bicycle frame are common. That may be, but that is not what claim 13 recites. Claim 13 recites "first and second mounting members structured to detachably mount a first or second electrical bicycle component to the housing." Thus, claim 13 is directed to mounting electrical components to the housing, not to the mere mounting of the entire apparatus to the bicycle frame.

Claim 19

Claim 19 recites wherein signals communicated from the regulator to the first external terminal are adapted to be communicated to a display. There are no external output terminals (recited

in parent claim 1) on Kitamura's housing (20). Furthermore, Kitamura's display (24) is disposed within housing (20) and cannot be interpreted to be a bicycle component external to the housing as required by parent claim 1.

Claim 20

Claim 20 recites that the first external terminal is structured to communicate a data signal to a display. The final office action states that Copeland discloses a data signal output (44, 45) disposed on a housing and structured to communicate a data signal to display (24).

There is no display (24) in Copeland. Furthermore, claim 20 requires a first external terminal, not a generic "output," and Copeland's element (45) is a transformer, not an external terminal. Also, transformers generate power, not data. Finally, Copeland's terminal (44) only receives operating power from battery (3) or generator (14). No data is communicated across terminal (44).

Claim 21

Claim 21 recites a signal input disposed on the housing and structured to receive a signal from outside of the housing. The office action refers to Copeland's lines (40, 41) as signal inputs. However, lines (40, 41) are signal outputs from wall recharger (16). Lines (40, 41) are not signal inputs.

Claim 22

Claim 22 recites a waveform shaping circuit supported by the housing, wherein the waveform shaping circuit receives a signal from a signal input and provides a shaped signal as the data signal to the first external terminal.

The office action states that Copeland discloses a waveform shaping circuit (Figs. 6-13) supported by a housing, wherein the waveform shaping circuit receives a signal from a signal input and provides a shaped signal as a data signal to a first external terminal. As noted above for claim 21, the office action interpreted the signal input to be elements (40, 41). However, elements (40, 41)

are signal outputs from wall recharger (16). They are not signal inputs. Furthermore, the circuits shown in Figs. 6-13 are not relevant to the subject matter recited in claim 22.

Fig. 6 of Copeland discloses an embodiment of voltage regulator (6) (Fig. 1) that supplies operating voltage to headlamp (1). Voltage regulator (6) does not shape waveforms, it does not communicate signals to external terminals (23, 24), and any voltages appearing on terminals (23, 24) certainly are not data signals.

Fig. 7 of Copeland discloses an embodiment of a combined voltage regulator (6) and automatic cutoff circuit (7) (Fig. 1), wherein automatic cutoff circuit (7) switches off voltage regulator (6) when battery (3) is excessively discharged. As just noted, voltage regulator (6) does not shape waveforms, and it does not communicate signals to external terminals (23, 24), let alone data signals. Neither does automatic cutoff circuit (7).

Fig, 8 of Copeland discloses an embodiment of overvoltage protection circuit (8) (Fig. 1) that prevents battery (3) from being overcharged. Overvoltage protection circuit (8) does not shape waveforms, it does not communicate signals to external terminals (23, 24), and any voltages appearing on terminals (23, 24) certainly are not data signals.

Fig. 9 of Copeland discloses an embodiment of fuse circuit (9) (Fig. 1) that cuts off current in the event of a short circuit between terminals (23) and (24). Fuse circuit (9) does not shape waveforms, it does not communicate signals to external terminals (23, 24), and any voltages appearing on terminals (23, 24) certainly are not data signals.

Fig. 10 of Copeland discloses an alternative embodiment of a rectifier that could be used in rectifier/voltage limiter circuit (10) (Fig. 1). Rectifier/voltage limiter circuit (10) provides only operating power, not data signals, to the remainder of the circuit. Furthermore, since the "signal input" was interpreted to be terminals (40, 41), it should be noted that terminals (40, 41) are part of wall recharger (16). Wall recharger (16) is disconnected from the remainder of the circuit when rectifier/voltage limiter circuit (10) is connected to terminals (23, 24). Thus, the circuit in Fig. 10 never receives signals from "signal inputs" (40, 41).

Fig. 11 of Copeland discloses an embodiment of oscillator (11) (Fig. 1) used to control the rate of flashing of rear lamp (5). Oscillator (11) does not provide signals to terminals (43,44), and any voltages appearing on terminals (43,44) certainly are not data signals.

Fig. 12 of Copeland discloses an embodiment of a flashtube trigger circuit (12) used to control the operation of lamp (5). Flashtube trigger circuit (12) does not shape waveforms, it does not provide signals to terminals (43,44), and any voltages appearing on terminals (43,44) certainly are not data signals.

Fig. 13 is the complete schematic diagram of rear warning lights (13) that incorporates the schematics shown in Figs. 11 and 12. Thus, the discussion immediately above for Figs. 11 and 12 apply to Fig. 13 as well.

In any event, a claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR International Co. v. Teleflex Inc.* 550 U.S. __, 82 USPQ2d 1385, 1396 (2007). No reasoning was provided as to why one of ordinary skill in the art would want to apply the teachings of Copeland to Kitamura in a manner relevant to claim 22.

Claim 23

Claim 23 recites wherein the signal input is structured to receive a signal from an alternating current generator. Since the "signal input" was interpreted to be terminals (40, 41), it should be noted that terminals (40, 41) are part of wall recharger (16). Wall recharger (16) is disconnected from the remainder of the circuit when generator (14) and rectifier/voltage limiter circuit (10) are connected to terminals (23, 24). Thus, terminals (40, 41) are not structured to receive a signal from an alternating current generator.

Claim 24

Claim 24 recites wherein the regulator receives the signal from the alternating current generator and uses the signal from the alternating current generator to provide power to the first external terminal to power the display. Copeland does not disclose a display as alleged. Furthermore,

Copeland's voltage regulator (6) provides regulated voltage to a headlight bulb (1) disposed within headlamp unit (17). The regulated voltage is not provided to external terminals to power anything outside of headlamp unit (17). Only unregulated battery voltage is supplied to terminals (23) and (24).

Claim 25

Claim 25 recites a power storage element supported by the housing for storing power from the alternating current generator. The office action states that Copeland discloses a power storage element (battery 3) supported by the housing for headlamp unit (17), but no further analysis was provided.

A claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR International Co. v. Teleflex Inc.* 550 U.S. __, 82 USPQ2d 1385, 1396 (2007). No reasoning was provided as to why one of ordinary skill in the art would want to apply the teachings of Copeland to Kitamura's housing (20) in a manner relevant to claim 25.

Claim 26

Independent claim 26 recites a housing adapted to be mounted to the bicycle, and a voltage regulator supported by the housing to receive signals from a power supply. The final office action refers to Kitamura's control panel (20) as a housing and refers to Kitamura's voltage regulator (43) as the recited regulator. However, as shown in Fig. 5 of Kitamura, voltage regulator (43) is part of power supply (27) which, as stated at column 4, lines 47-51, is housed within control box (31) mounted to the middle of the bicycle as shown in Fig. 2. Thus, given the interpretation in the office action, voltage regulator (43) is not supported by Kitamura's control panel (housing) (20) as required by claim 26.

Claim 26 also recites first and second external output terminal disposed on the housing. Kitamura's outputs (44, 45) are not disposed on housing (20) as alleged in the office action. As

shown in Kitamura's Fig. 6, outputs (44, 45) are part of power supply (27) which, as noted above, is housed within control box (31), not in control panel (housing) (20).

Copeland discloses a removable headlamp unit (17) wherein a voltage regulator (6) provides regulated voltage to a headlight bulb (1) disposed within headlamp unit (17). The regulated voltage is not provided to anything outside of headlamp unit (17). Only unregulated battery voltage is supplied to terminals (23) and (24). Thus, like Kitamura, Copeland also fails to disclose first and second external terminals disposed on a housing to supply regulated signals to first and second bicycle electrical components external to the housing. Even if the teachings of Copeland were applied to Kitamura, the result would not be the claimed invention. The result would be a system wherein regulated voltage is supplied to internal components, such as Kitamura's corresponding headlamp (18a, 18b, Fig. 1) mounted to front fork (3).

Claim 26 also recites how the voltage regulator provides first and second different non-ground voltages, each of which is adapted to power respective first and second electrical bicycle components. Kitamura provides a single non-ground signal at terminal (44), and the same is true for Copeland's regulator circuit (6). Thus, neither Kitamura nor Copeland discloses or suggests the subject matter presently claimed.

The statement at page 2, paragraph 3, of the office action that one cannot attack references individually does not apply to the present situation. When an office action alleges that a reference discloses a particular feature, it is entirely proper to show how that reference does not show that feature. Also, it is entirely proper to point out that *none* of the references discloses or suggests a particular element.

Finally, when discussing the location of the outputs on the housing at pages 2-3, the office action cites *In re Japikse* for the proposition that rearranging parts of an invention involves only routine skill in the art. However, that reasoning is an example of the application of a *per se* rule of obviousness that "is legally incorrect and must cease." In re Ochiai 71 F.3d 1565, 1572; 37 USPQ.2d 1127, 1133 (Fed.Cir. 1995). *See, also,* Ex Parte Granneman, 68 USPQ.2d 1219 (BdPatApp&Int 2003) (Unpublished). The office action did not compare the facts in *Japikse* with those in the present

case and explain why, based upon this comparison, the legal conclusion in the present case should be the same as that in *Japikse*.

Claim 27

Independent claim 27 recites a housing adapted to be mounted to the bicycle, and a regulator supported by the housing to receive signals from a signal source. The final office action refers to Kitamura's control panel (20) as a housing and refers to Kitamura's voltage regulator (43) as the recited regulator. However, as shown in Fig. 5 of Kitamura, voltage regulator (43) is part of power supply (27) which, as stated at column 4, lines 47-51, is housed within control box (31) mounted to the middle of the bicycle as shown in Fig. 2. Thus, given the interpretation in the office action, voltage regulator (43) is not supported by Kitamura's control panel (housing) (20) as required by claim 27.

Claim 27 further recites a plurality of mounting members disposed on the housing to directly attach a corresponding plurality of electrical bicycle components to the housing. An external output terminal is disposed on the housing in close proximity to each mounting member to supply regulated non-ground signals provided by the regulator to corresponding ones of the plurality of electrical bicycle components mounted to the plurality of mounting members. Neither Kitamura nor Copeland discloses such a plurality of mounting members or external output terminals disposed on the housing in close proximity to each mounting member, and the office action does not indicate where such structures may exist in either Kitamura or Copeland.

Finally, when discussing the location of the outputs on the housing at paragraph number 5 bridging pages 2-3, the office action cites *In re Japikse* for the proposition that rearranging parts of an invention involves only routine skill in the art. However, that reasoning is an example of the application of a *per se* rule of obviousness that "is legally incorrect and must cease." In re Ochiai 71 F.3d 1565, 1572; 37 USPQ.2d 1127, 1133 (Fed.Cir. 1995). *See, also,* Ex Parte Granneman, 68 USPQ.2d 1219 (BdPatApp&Int 2003) (Unpublished). The office action did not compare the facts in *Japikse* with those in the present case and explain why, based upon this comparison, the legal conclusion in the present case should be the same as that in *Japikse*.

Claim 28

Independent claim 28 recites a housing adapted to be mounted to the bicycle, and a regulator supported by the housing to receive signals from a signal source. The final office action refers to Kitamura's control panel (20) as a housing and refers to Kitamura's voltage regulator (43) as the recited regulator. However, as shown in Fig. 5, voltage regulator (43) is part of power supply (27) which, as stated at column 4, lines 47-51 of Kitamura, is housed within control box (31) mounted to the middle of the bicycle as shown in Fig. 2. Thus, given the interpretation in the office action, voltage regulator (43) is not supported by Kitamura's control panel (housing) (20) as required by claim 28.

Claim 28 further recites a mounting member adapted to directly mount each one of a plurality of electrical bicycle components to that mounting member, each electrical bicycle component having different non-ground signal requirements. An external output terminal is disposed on the housing to supply regulated non-ground signals provided by the regulator to each of the plurality of electrical bicycle components when individually mounted to the mounting member. Neither Kitamura nor Copeland discloses such a mounting member or external output terminal disposed on the housing to supply regulated non-ground signals provided by the regulator to each of the plurality of electrical bicycle components when individually mounted to the mounting member, and the office action does not indicate where such structures may exist in either Kitamura or Copeland.

Finally, when discussing the location of the outputs on the housing at paragraph number 5 bridging pages 2-3, the office action cites *In re Japikse* for the proposition that rearranging parts of an invention involves only routine skill in the art. However, that reasoning is an example of the application of a *per se* rule of obviousness that "is legally incorrect and must cease." In re Ochiai 71 F.3d 1565, 1572; 37 USPQ.2d 1127, 1133 (Fed.Cir. 1995). *See, also,* Ex Parte Granneman, 68 USPQ.2d 1219 (BdPatApp&Int 2003) (Unpublished). The office action did not compare the facts in *Japikse* with those in the present case and explain why, based upon this comparison, the legal conclusion in the present case should be the same as that in *Japikse*.

Claim 30

Claim 30 recites how the regulator includes a waveform shaping circuit that is structured to convert am electrical signal from an alternating current generator into a pulsed signal.

The office action states that Copeland discloses a waveform shaping circuit (Figs. 6-13) supported by the housing, wherein the waveform shaping circuit receives a signal from a signal input and provides a shaped signal as a data signal to the first external terminal. However, that is not what claim 30 recites, so the office action does not properly address the requirements of claim 30.

In any event, the office action interpreted Copeland's regulator circuit (6) to be the regulator recited in claim 1. Fig. 6 of Copeland discloses an embodiment of voltage regulator (6) (Fig. 1) that supplies operating voltage to headlamp (1). Voltage regulator (6) does not shape waveforms, and it does not generate pulsed signals.

Fig. 7 of Copeland discloses an embodiment of a combined voltage regulator (6) and automatic cutoff circuit (7) (Fig. 1), wherein automatic cutoff circuit (7) switches off voltage regulator (6) when battery (3) is excessively discharged. As just noted, voltage regulator (6) does not shape waveforms, and it does not generate pulsed signals. Neither does automatic cutoff circuit (7).

Fig, 8 of Copeland discloses an embodiment of overvoltage protection circuit (8) (Fig. 1) that prevents battery (3) from being overcharged. Overvoltage protection circuit (8) is not part of regulator circuit (6), it does not shape waveforms, and it does not generate pulsed signals.

Fig. 9 of Copeland discloses an embodiment of fuse circuit (9) (Fig. 1) that cuts off current in the event of a short circuit between terminals (23) and (24). Fuse circuit (9) is not part of regulator circuit (6), it does not shape waveforms, and it does not generate pulsed signals.

Fig. 10 of Copeland discloses an alternative embodiment of a rectifier that could be used in rectifier/voltage limiter circuit (10) (Fig. 1). Rectifier/voltage limiter circuit (10) is not part of regulator circuit (6).

Fig. 11 of Copeland discloses an embodiment of oscillator (11) (Fig. 1) used to control the rate of flashing of rear lamp (5). Oscillator (11) is not part of regulator circuit (6).

Fig. 12 of Copeland discloses an embodiment of a flashtube trigger circuit (12) (Fig. 1) used to control the operation of lamp (5). Flashtube trigger circuit (12) is not part of regulator circuit (6).

Fig. 13 is the complete schematic diagram of rear warning lights (13) that incorporates the schematics shown in Figs. 11 and 12. Thus, the discussion immediately above for Figs. 11 and 12 apply to Fig. 13 as well.

Claim 31

Claim 31 recites an auto-light circuit supported by the housing to provide signals through the first external terminal to automatically turn a light on and off. The office action states that Copeland discloses an auto light circuit (7, 8, 9) supported by the housing to provide signals through the first external terminal to automatically turn a light on and off. However, the only external terminals associated with headlamp unit (17) are terminals (23, 24), and neither low battery shutoff (7), overcharging protection circuit (8), nor fuse circuit (9) provides signals through terminals (23, 24) to turn lamp (1) on and off.

Claim 33

Claim 33 recites wherein the non-ground electrical signals provided from the regulator by the first external terminal are different from the non-ground electrical signals provided from the regulator by the second external terminal. Kitamura fails to disclose first and second external terminals, and Kitamura does not provide different non-ground signals to shift controller (9) and lamp controller (10a) as required by claim 33. In fact, the same power signal is provided to both components from regulator (43), albeit through different switches. Also, it cannot be said that the power signals provided to Kitamura's shift controller (9) and lamp controller (10a) are inherently different. A claim limitation is inherent in the prior art if it is *necessarily* present in the prior art, not merely probably or possibly present. *Rosco v. Mirror Lite*, 304 F.3d 1373, 1380; 64 USPQ2d 1676 (Fed.Cir. 2002).

Claim 35

Claim 35 recites wherein the output includes a third external terminal to provide separate non-ground electrical signals to a third electrical bicycle component, wherein the first, second and third external terminals are disposed in a row. The office action maintains that Fig. 4 of Kitamura discloses three external terminals in a row. However, Fig. 4 is a conceptual block diagram and does not represent the actual physical location of components. Also, there is no basis to conclude that Fig. 4 shows external output terminals. Finally, the signal lines from housing (20) provide signals to a single shift control unit (25). There are no first, second and third bicycle components.

The office action also cites *St. Regis Paper Co. v. Bemis Co.* for the proposition that mere duplication of the essential working parts of a device involves only routine skill in the art. However, that reasoning is an example of the application of a *per se* rule of obviousness that "is legally incorrect and must cease." In re Ochiai 71 F.3d 1565, 1572; 37 USPQ.2d 1127, 1133 (Fed.Cir. 1995). *See, also,* Ex Parte Granneman, 68 USPQ.2d 1219 (BdPatApp&Int 2003) (Unpublished). The office action did not compare the facts in *St. Regis Paper Co.* with those in the present case and explain why, based upon this comparison, the legal conclusion in the present case should be the same as that in *St. Regis Paper Co.*

Claims 36 and 41

Claim 36 depends from claim 8 and recites wherein the mounting member projects from a surface of the housing and is structured to detachably connect at least one of the first or second electrical bicycle components externally to the housing such that the at least one of the first or second electrical bicycle components cannot be detached in a direction substantially perpendicular to the surface of the housing. Claim 41 depends from claim 13 and recites wherein each of the first mounting member and the second mounting member projects from a surface of the housing and is structured to detachably connect at least one of first or second electrical bicycle components externally to the housing such that the at least one of the first or second electrical bicycle components cannot be detached in a direction substantially perpendicular to the surface of the housing.

The office action refers to Copeland's Fig. 3 as disclosing a mounting member, but the mounting member is not identified, and it is not explained how such a mounting member functions as recited in claims 36 and 41. In fact, Copeland teaches away from any such mounting member. Copeland discloses pieces (69) and (70) that contain various electrical components *inside* of the space formed by those pieces. The objective of Copeland is stated at column 10, lines 65-68: "It is an object of the invention to disclose a warning device that has all active electrical parts on a single circuit board *without parts mounted to the case*, sub-assemblies or loose wiring." (emphasis added) It cannot be said that Copeland discloses a mounting member for external devices when Copeland expressly seeks to avoid external mounting of components.

Furthermore, the mounting members were recited to be disposed on the housing. The office action previously interpreted the housing to be the housing for Copeland's headlamp unit (17). However, Figs. 2 and 3 show the structure of rear warning lamp (13). See column 13, lines 42-50. There appears to be improper equivocation for the term "housing." Copeland does fails to disclose any mounting member for housing (17).

Finally, page 4 of the office action cites *Nerwin v. Erlichman* for the proposition that constructing a formerly integral structure in various elements involves only routine skill in the art. However, that reasoning is an example of the application of a *per se* rule of obviousness that "is legally incorrect and must cease." In re Ochiai 71 F.3d 1565, 1572; 37 USPQ.2d 1127, 1133 (Fed.Cir. 1995). *See, also,* Ex Parte Granneman, 68 USPQ.2d 1219 (BdPatApp&Int 2003) (Unpublished). The office action did not compare the facts in *Nerwin* with those in the present case and explain why, based upon this comparison, the legal conclusion in the present case should be the same as that in *Nerwin*.

Claims 37 and 42

Claim 37 depends from claim 36 and recites wherein the mounting member has a wall that forms an abutment that faces in a direction toward the surface of the housing. Claim 42 depends from claim 41 and recites wherein each of the first mounting member and the second mounting member has a wall that forms an abutment that faces in a direction toward the surface of the housing.

The office action refers to Copeland's Fig. 3 as disclosing a wall on a mounting member, but the mounting member and its associated wall were not identified, and it is not explained how such a mounting member and wall have the structure recited in claims 37 and 42. In fact, Copeland teaches away from any such mounting member or wall. Copeland discloses pieces (69) and (70) that contain various electrical components *inside* of the space formed by those pieces. The objective of Copeland is stated at column 10, lines 65-68: "It is an object of the invention to disclose a warning device that has all active electrical parts on a single circuit board *without parts mounted to the case*, sub-assemblies or loose wiring." (emphasis added) It cannot be said that Copeland discloses a mounting member and wall for external devices when Copeland expressly seeks to avoid external mounting of components.

Furthermore, the mounting members were recited to be disposed on the housing. The office action previously interpreted the housing to be the housing for Copeland's headlamp unit (17). However, Figs. 2 and 3 show the structure of rear warning lamp (13). See column 13, lines 42-50. There appears to be improper equivocation for the term "housing." Copeland does fails to disclose any mounting member or wall for housing (17).

Finally, page 4 of the office action cites *Nerwin v. Erlichman* for the proposition that constructing a formerly integral structure in various elements involves only routine skill in the art. However, that reasoning is an example of the application of a *per se* rule of obviousness that "is legally incorrect and must cease." In re Ochiai 71 F.3d 1565, 1572; 37 USPQ.2d 1127, 1133 (Fed.Cir. 1995). *See, also,* Ex Parte Granneman, 68 USPQ.2d 1219 (BdPatApp&Int 2003) (Unpublished). The office action did not compare the facts in *Nerwin* with those in the present case and explain why, based upon this comparison, the legal conclusion in the present case should be the same as that in *Nerwin*.

Claims 38 and 43

Claims 38 depends from claim 37 and recites wherein the mounting member has a dovetail shape. Claim 43 depends from claim 42 and recites wherein at least one of the first mounting member and the second mounting member has a dovetail shape. The office action maintains that

Copeland's bracket (72) has a dovetail shape. However, bracket (72) clearly does not have a dovetail shape, and bracket (72) is not part of the housing (17). Neither Kitamura nor Copeland discloses mounting members with dovetail shapes disposed on a housing that supports a regulator and has external terminals.

Claim 39

Claim 39 recites wherein the first external terminal is disposed on the housing at a first side of the mounting member, and wherein the second external terminal is disposed on the housing at an opposite second side of the mounting member. The office action states that Copeland discloses such an arrangement of external terminals. However, Copeland discloses a single non-ground terminal (77) as shown in Fig. 3. The other terminal is a ground terminal. Furthermore, both terminals are disposed on the same side of any conceivable mounting member and are not disposed on opposite sides of a mounting member as required by claim 39.

Finally, the mounting members and external terminals were recited to be disposed on the housing. The office action previously interpreted the housing to be the housing for Copeland's headlamp unit (17). However, Figs. 2 and 3 show the structure of rear warning lamp (13). See column 13, lines 42-50. There appears to be improper equivocation for the term "housing." Copeland fails to disclose the subject matter recited in claim 39.

Claim 40

Claim 40 recites wherein the first external terminal is disposed on the housing at a first side of the mounting member, and wherein the second external electrical terminal is disposed on the housing at the first side of the mounting member. The office action states that Copeland discloses such an arrangement of external terminals. However, claim 40 requires two non-ground external terminals because of the ultimate dependency from claim 1. Copeland discloses a single non-ground terminal (77) as shown in Fig. 3. The other terminal is a ground terminal. Thus, Copeland fails to disclose two non-ground external terminals.

Finally, the mounting members and external terminals were recited to be disposed on the housing. The office action previously interpreted the housing to be the housing for Copeland's headlamp unit (17). However, Figs. 2 and 3 show the structure of rear warning lamp (13). See column 13, lines 42-50. There appears to be improper equivocation for the term "housing." Copeland fails to disclose the subject matter recited in claim 40.

Claim 44

Claim 44 recites the first and second external terminal being disposed on the housing at first sides of their corresponding first and second mounting members, wherein a third external terminal is disposed on an opposite second side of the first mounting member to provide electrical signals to the first electrical bicycle component, and wherein a fourth external terminal is disposed on an opposite second side of the second mounting member to provide electrical signals to the second electrical bicycle component. The office action maintains that Fig. 4 of Kitamura discloses three external terminals in a row, but that is not what claim 44 recites. Accordingly, claim 44 has not been properly addressed by the office action.

In any event, Kitamura's Fig. 4 is a conceptual block diagram and does not represent the actual physical location of components. Also, there is no basis to conclude that Fig. 4 shows external output terminals. Finally, the signal lines from housing (20) provide signals to a single shift control unit (25). There are no first and second bicycle components.

The office action also cites *St. Regis Paper Co. v. Bemis Co.* for the proposition that mere duplication of the essential working parts of a device involves only routine skill in the art. However, that reasoning is an example of the application of a *per se* rule of obviousness that "is legally incorrect and must cease." In re Ochiai 71 F.3d 1565, 1572; 37 USPQ.2d 1127, 1133 (Fed.Cir. 1995). *See, also,* Ex Parte Granneman, 68 USPQ.2d 1219 (BdPatApp&Int 2003) (Unpublished). The office action did not compare the facts in *St. Regis Paper Co.* with those in the present case and explain why, based upon this comparison, the legal conclusion in the present case should be the same as that in *St. Regis Paper Co.*

Rejection under 35 U.S.C. §103(a) over Kitamura and Copeland in view of Murashige, et al

Claims 10 and 17

Claims 10 and 17 are directed to mounting members that have one of a convex portion or a concave portion structured to engage a corresponding one of a concave portion or a convex portion on a corresponding bicycle component. Murashige, et al discloses a battery pack (100) for a tool (300) wherein prongs (17, 18) in tool (300) lockingly engage corresponding slots (15, 16) in battery pack (100). The office action states that it would be obvious to use Murashige, et al's terminal structure for the purpose of connecting the terminals of a battery pack.

It is initially submitted that claims 10 and 17 derive patentability from the claims from which they depend. Furthermore, Kitamura's housing (20) has no need for a battery pack. All power is communicated from control box (31). There is no reason to provide terminals to Kitamura's housing (20) to mount a battery pack.

Respectfully submitted,

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VIII. CLAIMS APPENDIX

CLAIM 1. An apparatus for providing electrical signals to bicycle components, wherein the apparatus comprises:

a housing adapted to be mounted to the bicycle;

a regulator supported by the housing to receive signals from a power supply; and

an output disposed on the housing to supply regulated signals provided by the regulator to a plurality of electrical bicycle components external to the housing;

wherein the output includes:

a first external terminal to provide non-ground electrical signals to a first electrical bicycle component; and

a separate second external terminal to provide separate non-ground electrical signals to a second electrical bicycle component.

CLAIM 2. The apparatus according to claim 1 wherein the output comprises a plurality of power communication paths, wherein a first power communication path connected to the first external terminal provides a physically different power characteristic from the regulator than a second power communication path connected to the second external terminal.

CLAIM 3. The apparatus according to claim 1 further comprising an input disposed on the housing to receive power from an external power supply and to supply the power from the external power supply to the regulator.

CLAIM 4. The apparatus according to claim 3 wherein the input is adapted to receive power from an alternating current generator.

CLAIM 5. The apparatus according to claim 4 further comprising a power storage element supported by the housing for storing power from the alternating current generator.

CLAIM 6. The apparatus according to claim 4 wherein the plurality of electrical bicycle components comprise a radio, a cell phone charger and a light.

CLAIM 7. The apparatus according to claim 1 wherein at least one of the first external terminal or the second external terminal is structured to be detachably connected to its corresponding first or second electrical bicycle component.

CLAIM 8. The apparatus according to claim 7 further comprising a mounting member disposed on the housing to detachably mount at least one of the first or second electrical bicycle components externally to the housing so that the at least one of the first or second electrical bicycle components is carried by the housing and electrical signals are provided from the at least one of the first external terminal or the second external terminal to the at least one of the first or second electrical bicycle components.

CLAIM 9. The apparatus according to claim 8 wherein the at least one of the first external terminal or the second external terminal comprises a contact terminal structured to contact a complementary contact terminal on its corresponding first or second electrical bicycle component when the corresponding first or second electrical bicycle component is mounted to the housing.

CLAIM 10. The apparatus according to claim 8 wherein a surface of the mounting member comprises one of a convex portion or a concave portion structured to engage a corresponding one of a concave portion or a convex portion on at least one of the first or second electrical bicycle components so that the at least one of the first or second electrical bicycle components cannot be detached in a direction substantially perpendicular to the surface of the mounting member from which the one of the convex portion or the concave portion extends.

CLAIM 11. The apparatus according to claim 8 wherein each of the first external terminal and the second external terminal is structured to be detachably connected to its corresponding first or second electrical bicycle component.

CLAIM 12. The apparatus according to claim 11 wherein the first external terminal and the second external terminal provide different physical power characteristics from the regulator relative to each other.

CLAIM 13. The apparatus according to claim 7 further comprising first and second mounting members disposed on the housing, each mounting member being structured to detachably mount a corresponding one of the first or second electrical bicycle components to the housing.

CLAIM 17. The apparatus according to claim 13 wherein each of the plurality of mounting members comprises one of a convex portion or a concave portion structured to engage a corresponding one of a concave portion or a convex portion on at least one of the first or second electrical bicycle components so that the at least one of the first or second electrical bicycle components cannot be detached in a direction substantially perpendicular to the surface of the mounting member from which the one of the convex portion or the concave portion extends.

CLAIM 18. The apparatus according to claim 13 wherein the first external terminal and the second external terminal provide different physical power characteristics from the regulator relative to each other.

CLAIM 19. The apparatus according to claim 1 wherein signals communicated from the regulator to the first external terminal are adapted to be communicated to a display.

CLAIM 20. The apparatus according to claim 19 wherein the first external terminal is structured to communicate a data signal to the display.

CLAIM 21. The apparatus according to claim 20 further comprising a signal input disposed on the housing and structured to receive a signal from outside of the housing.

CLAIM 22. The apparatus according to claim 21 further comprising a waveform shaping circuit supported by the housing, wherein the waveform shaping circuit receives the signal from the signal input and provides a shaped signal as the data signal to the first external terminal.

CLAIM 23. The apparatus according to claim 22 wherein the signal input is structured to receive a signal from an alternating current generator.

CLAIM 24. The apparatus according to claim 23 wherein the regulator receives the signal from the alternating current generator and uses the signal from the alternating current generator to provide power to the first external terminal to power the display.

CLAIM 25. The apparatus according to claim 24 further comprising a power storage element supported by the housing for storing power from the alternating current generator.

CLAIM 26. An apparatus for providing electrical signals to bicycle components, wherein the apparatus comprises:

a housing adapted to be mounted to the bicycle;

a voltage regulator supported by the housing to receive power from a power supply and to provide first and second different non-ground voltages, each of which is adapted to power respective first and second electrical bicycle components; and

first and second external output terminals disposed on the housing to supply the respective first and second different non-ground voltages from the regulator to the respective first and second electrical bicycle components external to the housing.

CLAIM 27. An apparatus for providing electrical signals to bicycle components, wherein the apparatus comprises:

a housing adapted to be mounted to the bicycle;

a regulator supported by the housing to receive signals from a signal source;

a plurality of mounting members disposed on the housing to directly attach a corresponding plurality of electrical bicycle components to the housing; and

an external output terminal disposed on the housing in close proximity to each mounting member to supply regulated non-ground signals provided by the regulator to corresponding ones of the plurality of electrical bicycle components mounted to the plurality of mounting members.

CLAIM 28. An apparatus for providing electrical signals to bicycle components, wherein the apparatus comprises:

a housing adapted to be mounted to the bicycle;

a regulator supported by the housing to receive signals from a signal source;

a mounting member adapted to directly mount each one of a plurality of electrical bicycle components to that mounting member, each electrical bicycle component having different non-ground signal requirements; and

an external output terminal disposed on the housing to supply regulated non-ground signals provided by the regulator to each of the plurality of electrical bicycle components when individually mounted to the mounting member.

CLAIM 29. The apparatus according to claim 1 wherein each first and second external terminal provides a detachable connection to its respective first and second electrical bicycle component.

CLAIM 30. The apparatus according to claim 1 wherein the regulator includes a waveform shaping circuit structured to convert an electrical signal from an alternating current generator into a pulsed signal.

CLAIM 31. The apparatus according to claim 1 further comprising an auto-light circuit supported by the housing to provide signals through the first external terminal to automatically turn a light on and off.

CLAIM 32. The apparatus according to claim 1 wherein the regulator is disposed within the housing.

CLAIM 33. The apparatus according to claim 1 wherein the non-ground electrical signals provided from the regulator by the first external terminal are different from the non-ground electrical signals provided from the regulator by the second external terminal.

CLAIM 34. The apparatus according to claim 1 wherein the non-ground electrical signals provided by the first external terminal and the second external terminal have a voltage in a range of from approximately 1.2 volts to approximately 3.7 volts.

CLAIM 35. The apparatus according to claim 1 wherein the output includes a third external terminal to provide separate non-ground electrical signals to a third electrical bicycle component, wherein the first, second and third external terminals are disposed in a row.

CLAIM 36. The apparatus according to claim 8 wherein the mounting member projects from a surface of the housing and is structured to detachably connect at least one of the first or second electrical bicycle components externally to the housing such that the at least one of the first or second electrical bicycle components cannot be detached in a direction substantially perpendicular to the surface of the housing.

CLAIM 37. The apparatus according to claim 36 wherein the mounting member has a wall that forms an abutment that faces in a direction toward the surface of the housing.

CLAIM 38. The apparatus according to claim 37 wherein the mounting member has a dovetail shape.

CLAIM 39. The apparatus according to claim 36 wherein the first external terminal is disposed on the housing at a first side of the mounting member, and wherein the second external terminal is disposed on the housing at an opposite second side of the mounting member.

CLAIM 40. The apparatus according to claim 39 wherein the first external terminal is disposed on the housing at a first side of the mounting member, and wherein the second external electrical terminal is disposed on the housing at the first side of the mounting member.

CLAIM 41. The apparatus according to claim 13 wherein each of the first mounting member and the second mounting member projects from a surface of the housing and is structured to detachably connect at least one of first or second electrical bicycle components externally to the housing such that the at least one of the first or second electrical bicycle components cannot be detached in a direction substantially perpendicular to the surface of the housing.

CLAIM 42. The apparatus according to claim 41 wherein each of the first mounting member and the second mounting member has a wall that forms an abutment that faces in a direction toward the surface of the housing.

CLAIM 43. The apparatus according to claim 42 wherein at least one of the first mounting member and the second mounting member has a dovetail shape.

CLAIM 44. The apparatus according to claim 41 wherein the first external terminal is disposed on the housing at a first side of the first mounting member, wherein the second external terminal is disposed on the housing at a first side of the second mounting member, and wherein the output further includes:

a third external terminal disposed on an opposite second side of the first mounting member to provide electrical signals to the first electrical bicycle component; and

a fourth external terminal disposed on an opposite second side of the second mounting member to provide electrical signals to the second electrical bicycle component.

IX. EVIDENCE APPENDIX

1) U.S. Patent No. 6,418,041 B1 issued to Kitamura, et al and entered into the record by the examiner in the office action dated June 20, 2006.

2) U.S. Patent No. 5,015,918 issued to Copeland and entered into the record by the examiner in the office action dated June 20, 2006.

3) U.S. Patent Application Publication No. 2004/0013938 naming Murashige, et al and entered into the record by the examiner in the office action dated May 3, 2007.

US006418041B1

(12) **United States Patent**
Kitamura

(10) **Patent No.: US 6,418,041 B1**
(45) **Date of Patent: Jul. 9, 2002**

(54) **BICYCLE POWER SUPPLY**

(75) Inventor: **Satoshi Kitamura**, Kitakatsuragi-gun (JP)

(73) Assignee: **Shimano, Inc.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/722,089**

(22) Filed: **Nov. 22, 2000**

(30) **Foreign Application Priority Data**

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(52) **U.S. Cl.** **363/125**; 362/473; 315/76

(58) **Field of Search** 363/125, 59, 60, 363/61, 89; 362/193, 473; 315/77, 76, 78

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,792,307 A * 2/1974 Baker 315/77
5,015,918 A * 5/1991 Copeland .... 362/473 X
5,247,430 A * 9/1993 Schwaller 362/473
5,661,645 A * 8/1997 Hochstein 363/89

* cited by examiner

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(57) **ABSTRACT**

A bicycle power supply circuit is provided whereby an AC voltage from an AC generator mounted on a bicycle is converted to a DC voltage, and the converted DC voltage is provided to an electrical component on the bicycle. The bicycle power supply circuit includes a first input terminal for connecting to a first AC generator output terminal of the AC generator, a second input terminal for connecting to a second AC generator output terminal of the AC generator, a first output terminal for connecting to the electrical component, and a second output terminal for connecting to the electrical component. A full-wave voltage rectifier circuit converts AC voltage presented at the first and second input terminals into a DC voltage, and a storage device is coupled to the voltage rectifier, wherein the storage device has a positive voltage terminal and a negative voltage terminal. The positive voltage terminal is coupled for providing a positive voltage signal to the first output terminal and the negative voltage terminal is coupled for providing a negative voltage signal to the second output terminal.

22 Claims, 8 Drawing Sheets

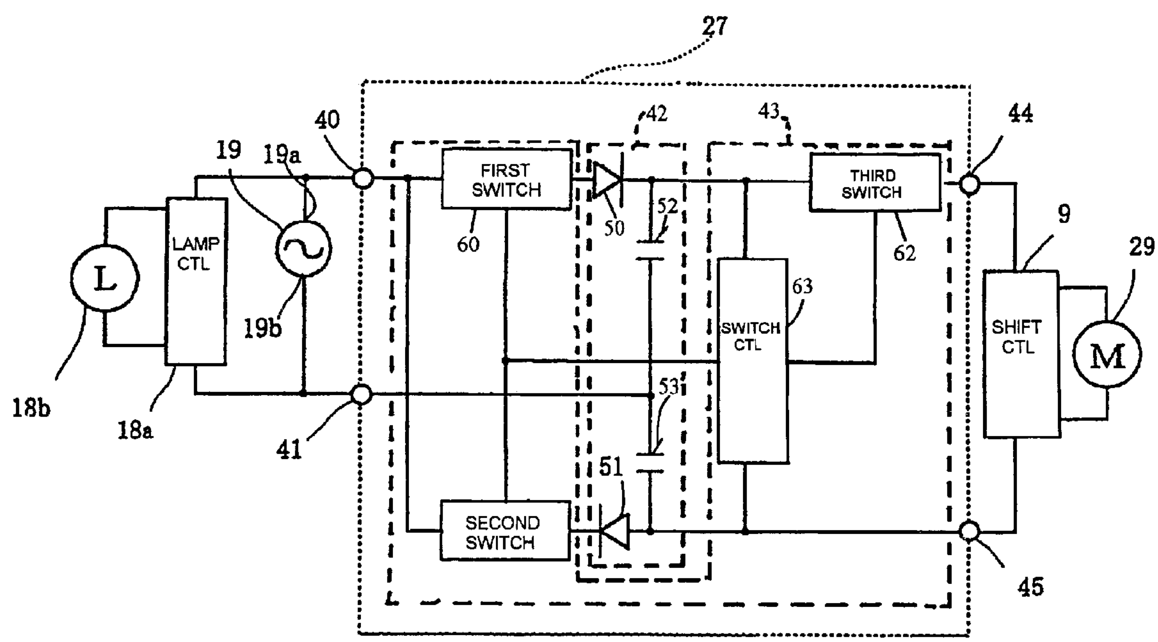


Fig. 1

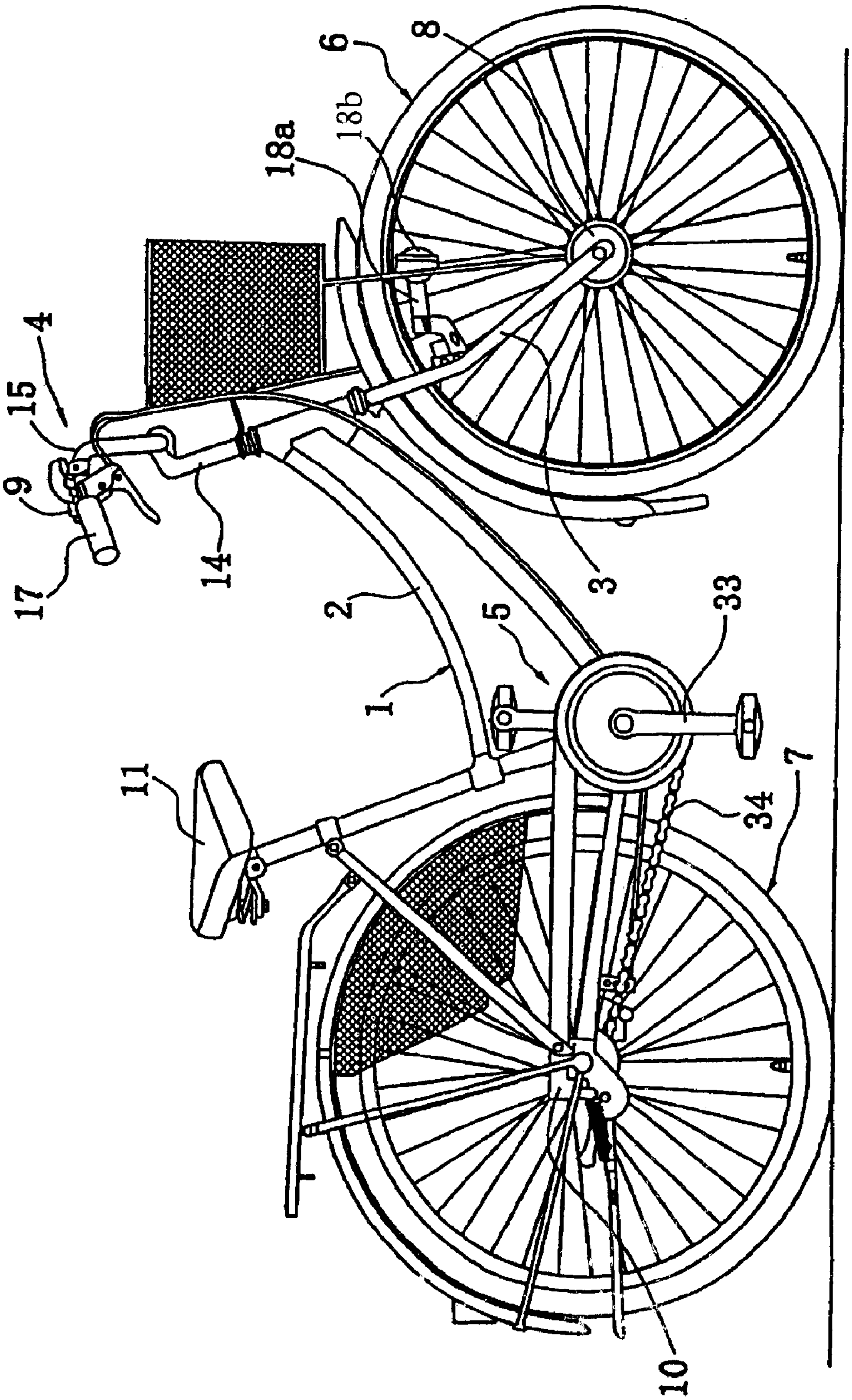
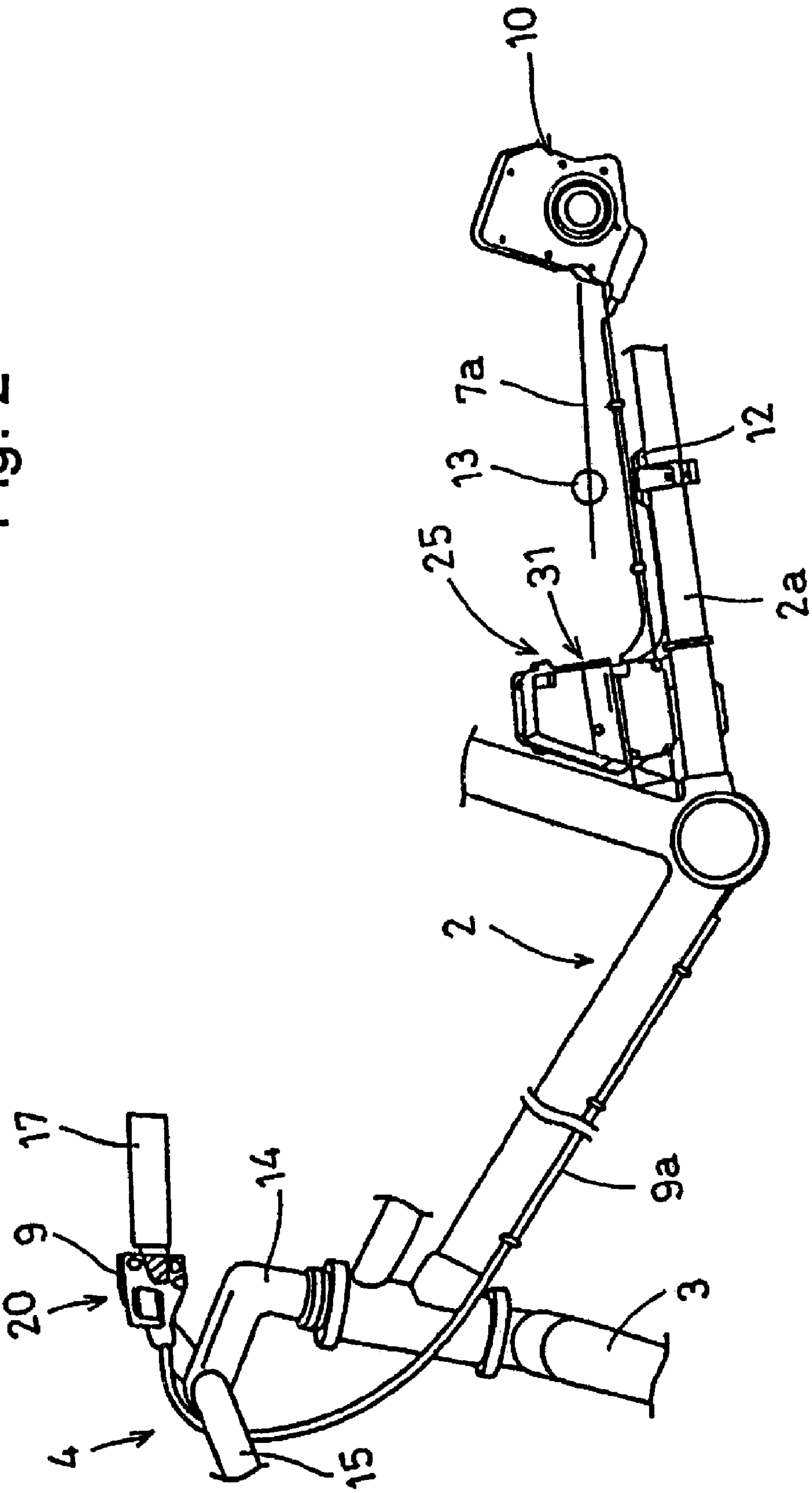


Fig. 2



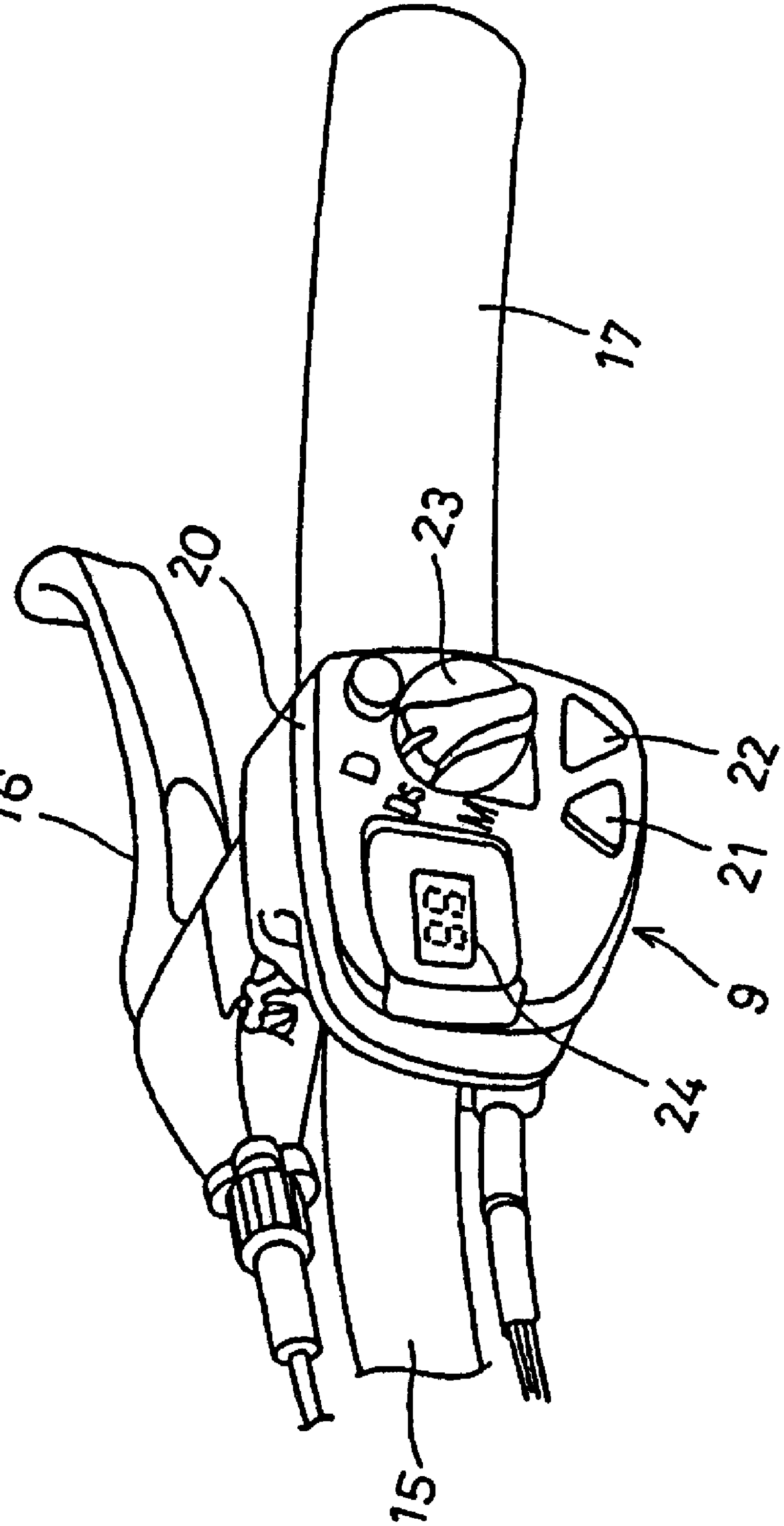


Fig. 3

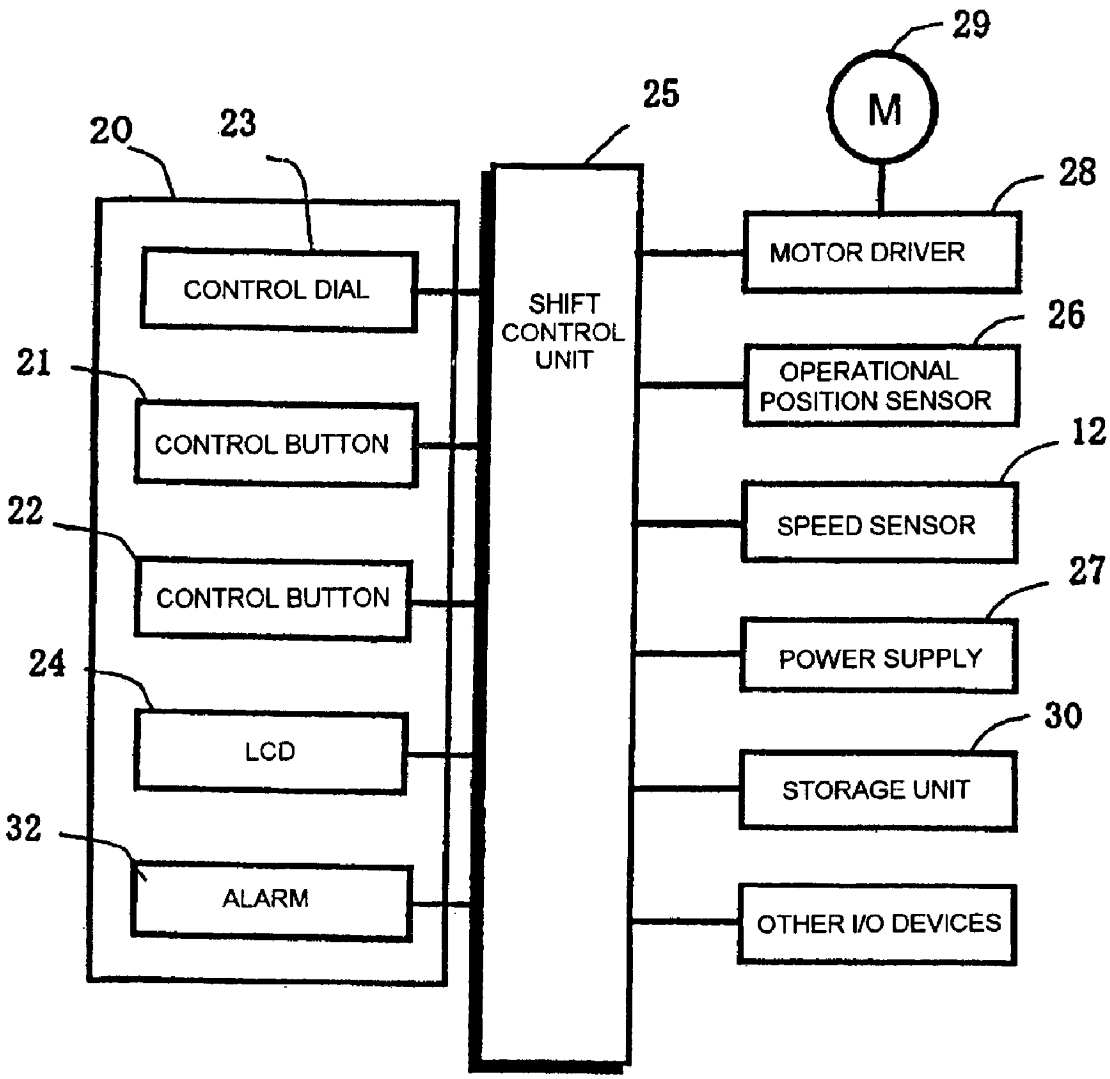
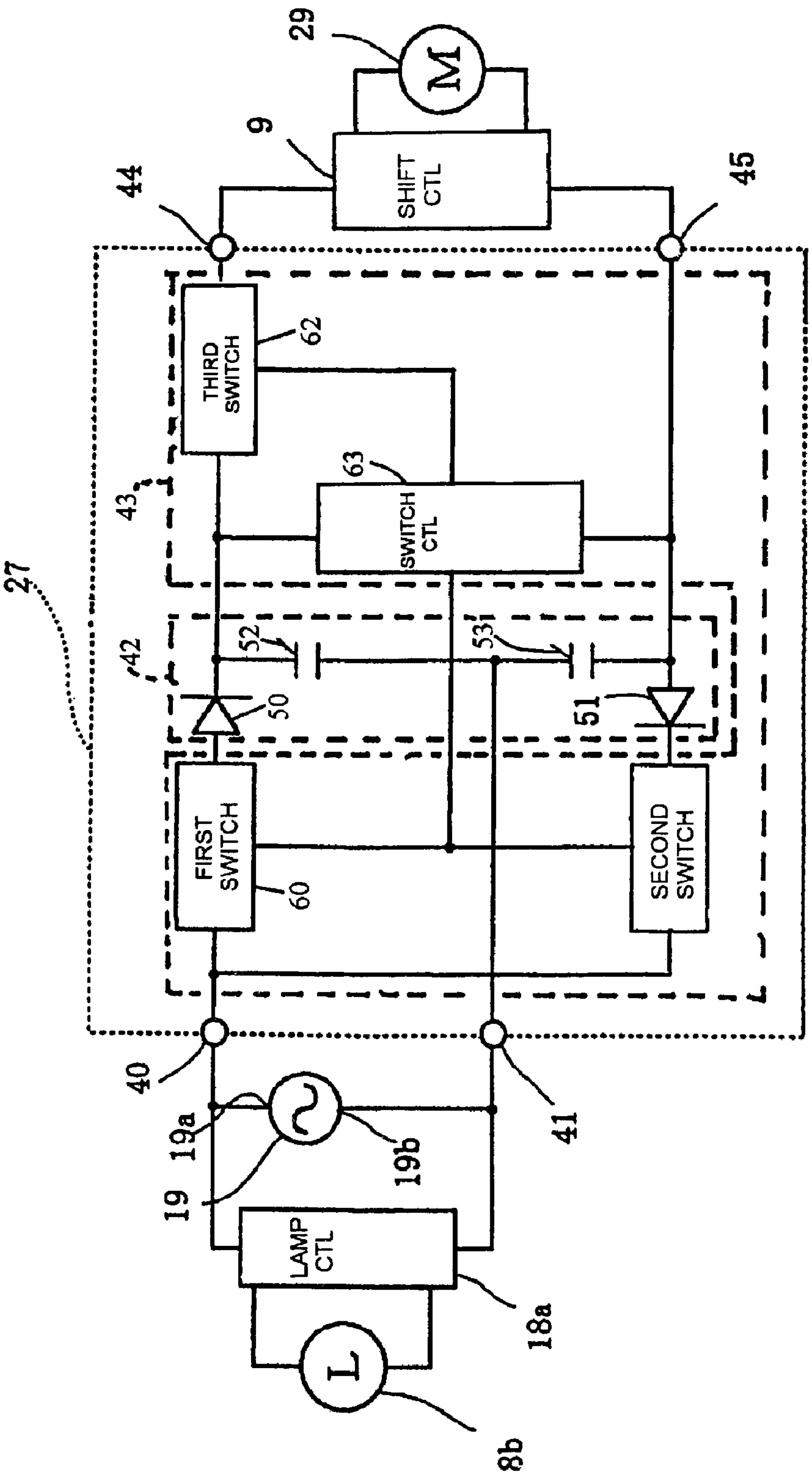

29
M
25
20
23
28
CONTROL DIAL
MOTOR DRIVER
SHIFT
CONTROL
UNIT
26
21
OPERATIONAL
POSITION SENSOR
CONTROL BUTTON
12
22
SPEED SENSOR
CONTROL BUTTON
27
24
POWER SUPPLY
LCD
30
STORAGE UNIT
32
ALARM
OTHER I/O DEVICES

Fig. 4



29
M
9
SHIFT CTL
44
45
THIRD SWITCH
62
63
SWITCH CTL
43
27
42
52
53
50
51
FIRST SWITCH
60
SECOND SWITCH
40
41
19a
19b
19
LAMP CTL
18a
L
18b

Fig. 5

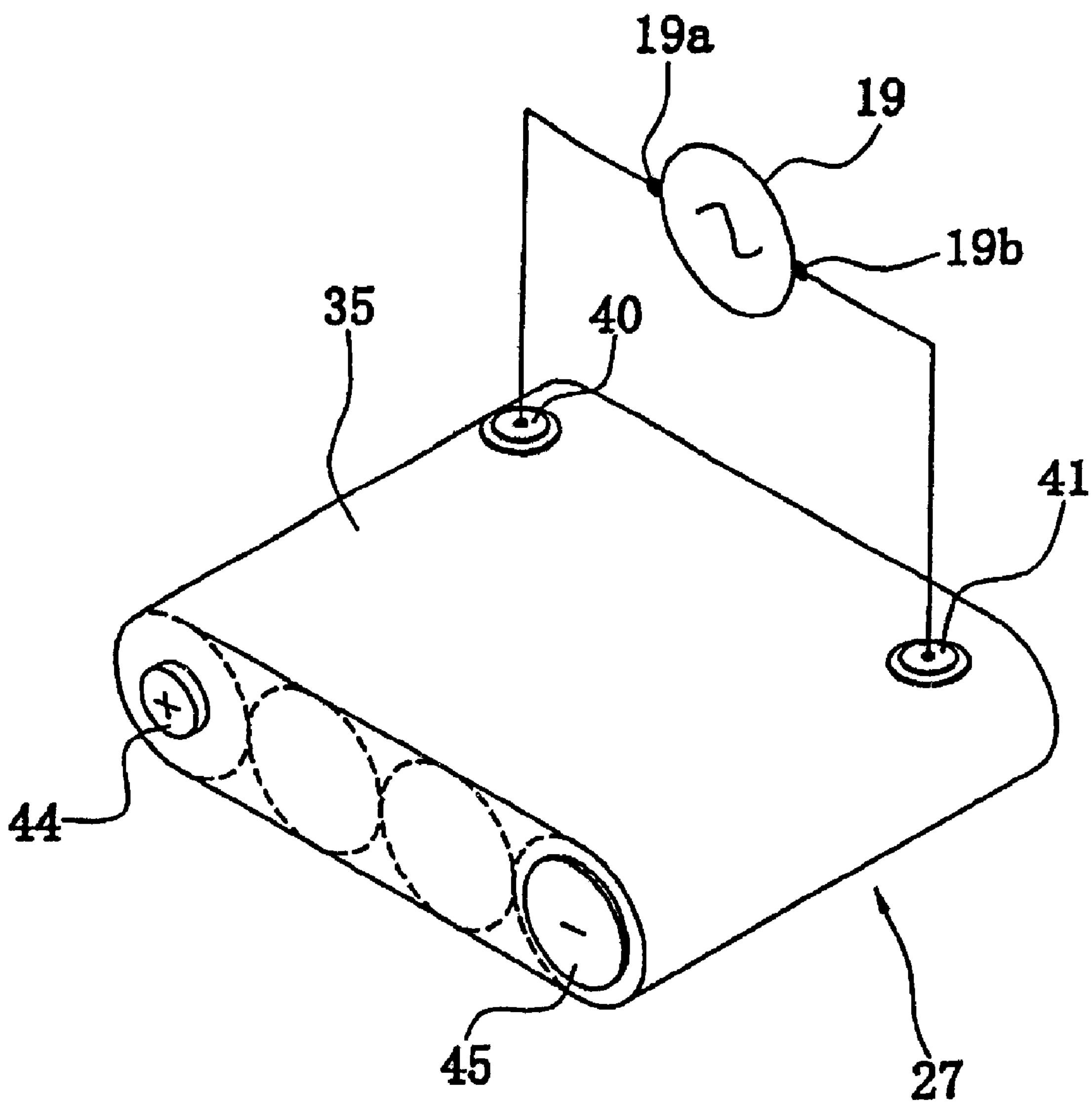


Fig. 6

Fig. 7

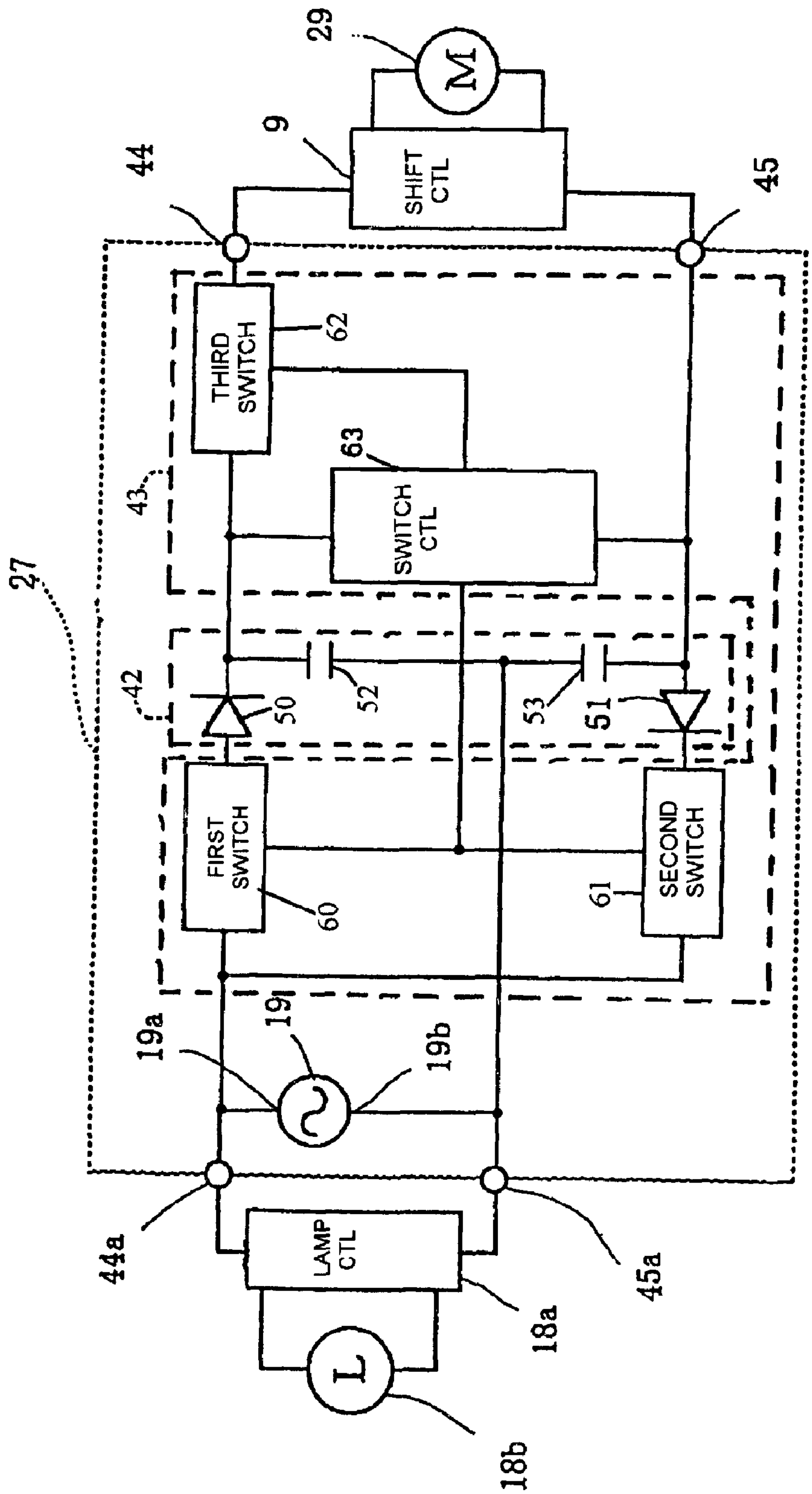
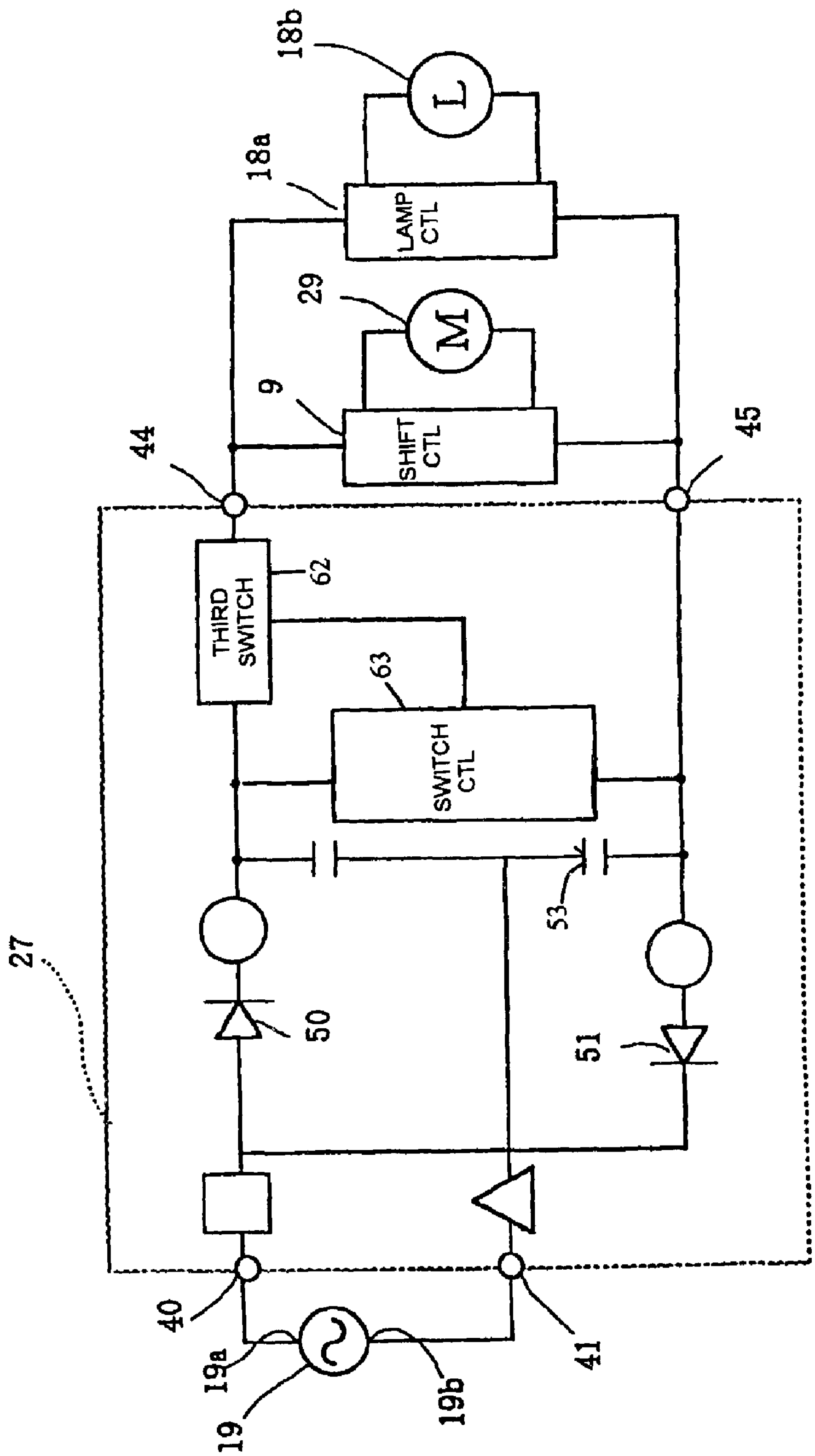

29
M
9
SHIFT CTL
44
45
THIRD SWITCH
62
63
SWITCH CTL
43
27
42
50
52
53
51
FIRST SWITCH
SECOND SWITCH
60
61
19a
19
19b
44a
45a
LAMP CTL
18a
L
18b

Fig. 8


18b
L
18a
LAMP CTL
29
M
9
SHIFT CTL
44
45
62
THIRD SWITCH
63
SWITCH CTL
53
27
50
51
40
41
19a
19
19b

BICYCLE POWER SUPPLY

BACKGROUND OF THE INVENTION

The present invention is directed to a bicycle power supply and, more particularly, to a bicycle power supply for providing electrical equipment mounted on a bicycle with a voltage produced by an AC generator mounted on the bicycle.

In conventional practice, headlights, taillights, and other types of illumination gear are commonly used as bicycle electrical equipment. Usually, dynamos (AC generators) are mounted on the bicycle to serve as the power supply for such electrical equipment. Currently, however, bicycles are being outfitted with more advanced electrical equipment such as electronically controlled shifters and other mechanisms, and power supplies are needed for the motors, control devices, and other types of electrical equipment used in such equipment. Thus, the power requirements of modern bicycles are becoming quite large.

Not surprisingly, it has been proposed to provide the electric power needed to operate all of the electrical equipment using a dynamo. However, the voltage generated by such a dynamo is an AC voltage, whereas the voltage needed for the electrical equipment is typically a DC voltage. It is therefore necessary to convert the AC voltage produced by the dynamo to a DC voltage. Furthermore, the maximum voltage produced by a dynamo is commonly low (about 8 V) and varies greatly with the travel speed of the bicycle. Thus, if the AC voltage is rectified with a half-wave rectifier circuit, full-wave rectifier circuit, or other type of rectifier circuit commonly used to rectify a 100-V commercial power supply, at some travel speeds it is impossible to provide the electrical equipment with sufficient voltage. Even when a sufficiently powerful voltage can be supplied, the rectified DC voltage varies with the travel conditions, thus making it impossible to provide electrical equipment with stable electric power. A failure to ensure a stable supply of sufficiently powerful voltage makes it more likely that the electrical equipment will malfunction.

SUMMARY OF THE INVENTION

The present invention is directed to a bicycle power supply circuit which provides a sufficiently powerful voltage to accommodate greater power demands of electrical equipment mounted on the bicycle. The present invention also is directed to a power supply which provides a stable voltage.

In one embodiment of the present invention, a bicycle power supply circuit is provided whereby an AC voltage from an AC generator mounted on a bicycle is converted to a DC voltage, and the converted DC voltage is provided to an electrical component on the bicycle. The bicycle power supply circuit includes a first input terminal for connecting to a first AC generator output terminal of the AC generator, a second input terminal for connecting to a second AC generator output terminal of the AC generator, a first output terminal for connecting to the electrical component, and a second output terminal for connecting to the electrical component. A full-wave voltage rectifier circuit converts AC voltage presented at the first and second input terminals into a DC voltage, and a storage device is coupled to the voltage rectifier, wherein the storage device has a positive voltage terminal and a negative voltage terminal. The positive voltage terminal is coupled for providing a positive voltage signal to the first output terminal, and the negative voltage terminal is coupled for providing a negative voltage signal to the second output terminal.

In a more specific embodiment, the voltage rectifier includes a first diode having an anode and a cathode and a second diode having an anode and a cathode. The anode of the first diode and the cathode of the second diode are coupled to the first input terminal. A first storage element has a first terminal coupled to the cathode of the first diode and a second terminal coupled to the second input terminal, and a second storage element has a first terminal coupled to the anode of the second diode and a second terminal coupled to the second input terminal.

With this bicycle power supply, voltage is applied to the full-wave voltage rectifier circuit from the first AC generator output terminal of the AC generator via the first input terminal, and charge is accumulated at maximum voltage in the first storage element during the positive half-periods of the voltage provided by the AC generator. Voltage is also applied to the full-wave voltage rectifier circuit from the second AC generator output terminal of the AC generator via the second input terminal, and charge is accumulated at maximum voltage in the second storage element during negative half-periods. As a result, a voltage $+Vc$ appears at the first output terminal, and a voltage $-Vc$ appears at the second output terminal, where Vc is the voltage of the dynamo appearing across the first and second input terminals. Thus, it is possible to output a voltage that is double the maximum voltage delivered by the AC generator, and sufficiently powerful voltage can be stably fed to electrical equipment even when the bicycle is ridden at a low speed as a result of the first and second storage elements.

In an embodiment of the invention that produces a stable voltage, a bicycle power supply circuit as described above includes a voltage regulator that regulates the voltage across the first and second output terminals at a prescribed value. This may be used also in power supplies that do not provide positive and negative voltages at the output terminals. In one embodiment of such a voltage regulator, a switch is disposed between the first input terminal and a storage device, and a switch control circuit is coupled to the switch, to the first output terminal and to the second output terminal. The switch is adapted to sense a voltage across the first and second output terminals and to selectively switch the switch to an off state. This, in turn, keeps the voltage at the first and second output terminals at the desired value.

In another embodiment of a voltage regulator, a switch is provided for switching off a signal at at least one of the first output terminal and the second output terminal, and a switch control circuit is coupled to the switch, to the first output terminal and to the second output terminal. The switch control circuit is adapted to sense a voltage across the first and second output terminals and to selectively switch the switch to an off state when a voltage across the first and second output terminals is less than a prescribed value. Thus, the voltage regulator shuts off the power supply when the voltage falls below a prescribed value to avoid potentially damaging the electronic components. Also, the power shut-off can reduce the charging time needed to return the voltage at the first and second output terminals to the desired value.

If desired, the storage elements may be capacitances, such as large-value capacitors that allow the charging time to be shortened and dimensions reduced. Alternatively, the storage elements may be rechargeable batteries that have a larger storage capacity than capacitors which, in turn, allow for a longer discharge time.

Another inventive feature is the provision of the power supply circuit in a case member that simulates a commercially available battery case. Such a case can simulate a

single commercially available battery or a group of commercially available batteries mounted in a commercially available battery case. In this manner a power supply according to the present invention may be inserted in place of a conventional battery, or a conventional battery may be inserted in place of the power supply in the event the power supply needs servicing or when the rolling resistance caused by the dynamo is undesirable in a particular situation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of a bicycle that incorporates a particular embodiment of a power supply circuit according to the present invention;

FIG. **2** is a fragmentary side view illustrating a layout of the shift controller used with the bicycle shown in FIG. **1**;

FIG. **3** is a portion of a particular embodiment of a hand operated shift control device used with the bicycle shown in FIG. **1**;

FIG. **4** is a block diagram illustrating a particular embodiment of the electrical components used in the shift controller shown in FIG. **2**;

FIG. **5** is a schematic diagram of a particular embodiment of a power supply circuit according to the present invention;

FIG. **6** is an external perspective view of a particular embodiment of a power supply case according to the present invention;

FIG. **7** is a schematic diagram of an alternative embodiment of a power supply circuit according to the present invention; and

FIG. **8** is a schematic diagram of another alternative embodiment of a power supply circuit according to the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

FIG. **1** is a side view of a bicycle that incorporates a particular embodiment of a power supply circuit according to the present invention. The bicycle comprises a frame **1** including a double-loop frame body **2** and a front fork **3**, a saddle **11**, a handle unit **4**, a drive unit **5**, a front wheel **6** on which a brake-equipped dynamo hub **8** is mounted, a rear wheel **7** provided with a four-speed internal shifter hub **10**, a shift controller **9** for the manual operation of the internal shifter hub **10**, and a lamp control unit **18***a*.

The handle unit **4** comprises a handle stem **14** fixed to the top portion of the front fork **3** and a handle bar **15** fixed to the handle stem **14**. A brake lever **16** (FIG. **3**) and a grip **17** are mounted on either end of the handle bar **15**. The control panel **20** of the shift controller **9** is formed integrally with the right-side brake lever **16**.

As shown in FIG. **1**, the drive unit **5** comprises a gear crank **33** attached to the lower portion (bottom bracket) of the frame body **2**, a chain **34** extending around the gear crank **33**, and the internal shifter hub **10**. The internal shifter hub **10** is a four-speed internal shifter hub that can be shifted into five positions (four shifting positions and one antitheft position) by a shifting motor **29**, which is described below. The rotation of the rear wheel **7** can be restricted or blocked when internal shifter hub **10** is in the antitheft position.

The dynamo hub **8** of the front wheel **6** fixed to the front end of the front fork **3** includes an externally mounted roller-type front brake and serves as an enclosure for an AC generator **19** (FIG. **5**) for generating electricity by the rotation of the front wheel **6**. The lamp control unit **18***a* is mounted in the midportion of the front fork **3**. The lamp control unit **18***a* performs a control procedure whereby an integrally mounted lamp **18***b* is switched on when ambient luminosity falls beyond a prescribed level and is switched off when a certain brightness level is exceeded. The lamp control unit **18***a* is connected to the AC generator **19**.

As shown in FIG. **3**, in this embodiment the shift controller **9** comprises two control buttons **21** and **22** aligned to the right and left in the bottom portion of the control panel **20**, a control dial **23** disposed above the control buttons **21** and **22**, and a liquid-crystal display **24** disposed to the left of the control dial **23**. The shift controller **9** communicates with a shift control unit **25** in a control box **31** (FIG. **2**) mounted at the base of the chain stay **2***a*. The components housed in the control panel **20** are connected to the shift control unit **25** by a control cable **9***a*. As shown in FIG. **2**, a speed sensor **12** provided with an internal lead switch for speed sensing is mounted on the chain stay **2***a* of the frame body **2**. The speed sensor **12** outputs a speed signal to shift controller **9** by sensing a magnet **13** mounted on a spoke **7***a* of the rear wheel **7**.

The control buttons **21** and **22** are triangular pushbuttons. The left-side control button **21** is a downshifting button, and the right-side control button **22** is an upshifting button. The control dial **23**, which is used to switch between two shift modes and an antitheft or parking (P) mode, has four stationary positions (P, D, Ds, and M). As referred to herein, the shift modes comprise an automatic shift **1** (D) mode, an automatic shift **2** (Ds) mode, and a manual shift (M) mode. The automatic shift **1** (D) mode and automatic shift **2** (Ds) mode allow the internal shifter hub **10** to be automatically shifted by a speed signal from the speed sensor **12**, whereas the manual shift mode (M) allows the internal shifter hub **10** to be shifted by operating the control buttons **21** and **22**. The parking mode (P) is used to lock the internal shifter hub **10** and to prevent the rear wheel **7** from rotating. The liquid-crystal display **24** displays the current travel speed and the speed step engaged during shifting.

The shift control unit **25** is provided with a microcomputer comprising a CPU, a RAM, a ROM, and an I/O interface. The shift control unit **25** controls the internal shifter hub **10** in accordance with the control operations performed with the control panel **20**, as well as the information displayed by the liquid-crystal display **24**. As shown in FIG. **4**, the control dial **23**, the control buttons **21** and **22**, the liquid-crystal display **24**, and an alarm **32** are connected to the shift control unit **25**. Also connected to the shift control unit **25** are, for example, an operating position sensor **26** composed of a potentiometer, a power supply **27** housed in the control box **31**, a motor driver **28**, a storage unit **30** for storing various types of data, and other input/output devices. A shifting motor **29** for driving the internal shifter hub **10** is connected to the motor driver **28**, and the operating position sensor **26** senses the operating position (parking position or one of the four shifting positions) of the shifting motor **29**.

As shown in FIG. **5**, the power supply **27** is connected to the AC generator **19** in parallel with the lamp control unit **18***a*. The power supply **27** converts AC voltage to DC voltage, stores the result, and feeds the stored DC voltage to the shift controller **9**. As noted above, power supply **27** is housed in the control box **31**. As shown in FIG. **6**, the power supply **27** has a case member **35** with an internal housing space and an external shape that conforms to the standard for commercially available batteries. An example is an oval shape capable of accommodating four AA batteries whose positive and negative poles are alternately oriented in opposite directions. Thus, control box **31** can accept either a

conventional commercially available battery or a case member 31 according to the present invention. This allows emergency power to be supplied by a commercial battery during a breakdown or other emergency. The case member can also be mounted instead of a battery on an existing control box.

As shown in FIG. 5, the power supply 27 comprises a first input terminal 40, a second input terminal 41, a full-wave voltage rectifier circuit 42, a voltage regulator 43, a first output terminal 44, and a second output terminal 45. As shown in FIG. 6, in this embodiment the first input terminal 40 is disposed on the external peripheral surface of the case member 35, and it is connected to the positive-voltage output terminal 19*a* of the AC generator 19. Similarly, the second input terminal 41 is disposed on the external peripheral surface of the case member 35 in alignment with the first input terminal 40, and it is connected to the negative-voltage output terminal 19*b* of the AC generator 19. The first output terminal 44 is located on the case member 35 at a position normally occupied by the positive terminal on a commercially available battery case, and the second output terminal 45 is located on the case member 35 at a position normally occupied by the negative terminal on a commercially available battery case. The shift controller 9 is coupled as a load to the two output terminals 44 and 45.

The full-wave voltage rectifier circuit 42 can store and output an AC voltage that is double the AC voltage presented by the two input terminals 40 and 41. The full-wave voltage rectifier circuit 42 comprises a first diode 50 whose anode terminal is coupled to the first input terminal 40; a second diode 51 whose cathode terminal is coupled to the first input terminal 40; a first storage element 52 in which one end is coupled to the cathode terminal of the first diode 50 and the other end is coupled to the second input terminal 41; and a second storage element 53 in which one end is coupled to the second input terminal 41 and the other end is coupled to the anode terminal of second diode 51. In this embodiment, each of the two storage elements 52 and 53 features an electric double layer capacitor or other large-capacity capacitor and serves to store and smooth the DC voltage rectified by the diodes 50 and 51.

The voltage regulator 43 is an output circuit for keeping the DC voltage produced by the full-wave voltage rectifier circuit 42 at a level not exceeding a first prescribed voltage (for example, 10 V), which is lower than the double voltage. This arrangement makes it possible to protect the storage elements 52 and 53 of the full-wave voltage rectifier circuit 42. The voltage regulator 43 comprises a first switch circuit 60 interposed between the first input terminal 40 and the first diode 50 and designed to make or break the connection between the two; a second switch circuit 61 interposed between the first input terminal 40 and the second diode 51 and designed to make or break the connection between the two; a third switch circuit 62 for switching on or off the DC voltage presented to the first and second output terminals 44 and 45; and a switch control circuit 63 for controlling the switch circuits 60–62. The three switch circuits 60–62 may, for example, feature field-effect transistors or other switching elements that are switched on or off by the control signals from the switch control circuit 63.

Both ends of the switch control circuit 63 are coupled to the first and second output terminals 44 and 45, the voltage between the two output terminals 44 and 45 is sensed, and when the sensed voltage exceeds the first prescribed voltage, the first and second switch circuits 60 and 61 remain switched off for as long as the voltage is above the first prescribed voltage. In addition, the switch control circuit 63 switches off the third switch circuit 62 if the sensed voltage falls below a second prescribed voltage (for example, 4 V), which is lower than the first prescribed voltage.

The operation of the power supply 27 will now be described. With the power supply 27 thus configured, the AC generator 19 starts generating electricity when the bicycle is ridden and the front wheel 6 rotates. Current flows through the first diode 50 via the first switch circuit 60 during the positive half-periods of the input voltage applied from the output terminals 19*a* and 19*b* of the AC generator 19, thus charging the first storage element 52 to maximum positive AC voltage (e.g., +Vc). Current flows through the second diode 51 via the second switch circuit 61 during the negative half-periods of the input voltage applied from the output terminals 19*a* and 19*b* of the AC generator 19, thus charging the first storage element 52 to maximum negative AC voltage (e.g., −Vc). As a result, the voltage between the two output terminals 44 and 45 (that is, the output voltage) is equal to the combined voltage resulting from the charging of the two storage elements 52 and 53, and the output voltage becomes double the maximum supply voltage of the AC generator 19.

The two switch circuits 60 and 61 are controlled by the switch control circuit 63 to produce a first prescribed voltage below the double supply voltage, so constant voltage less than double the supply voltage is produced. In addition, the third switch circuit 62 is switched off when the bicycle is ridden at a lower speed and the output voltage drops below the second prescribed voltage. This prevents power from being supplied to the shift controller 9 until the system is charged to a voltage equal to or greater than the second prescribed voltage.

The foregoing arrangement allows sufficiently powerful voltage to be applied to the shift controller 9 even when the bicycle is ridden at a low speed because it is possible to deliver double the maximum voltage produced by the AC generator 19, and such voltage is stored in storage elements 51 and 52. In addition, the voltage thus delivered is kept constant by the switch control circuit 63, thus making it possible to provide the shift controller 9 with power whose voltage is stabilized even under variable speed conditions. Consequently, power can be delivered in a secure manner to electrical equipment based on microcomputers.

While the above is a description of various embodiments of the present invention, further modifications may be employed without departing from the spirit and scope of the present invention. For example, although the above embodiment was described with reference to a case in which a dynamo within a hub was used as an AC generator, the present invention is also applicable to cases in which AC voltage is generated by a conventional rim-contacting dynamo in contact with the rim or tire. Although the above embodiment was described with reference to a case in which a shift control device served as the power recipient, the present invention is not limited to this option alone and includes electrical equipment for using electricity to control a bicycle suspension or the like, as well as any other type of electrical equipment for a bicycle.

Although the above embodiment was described with reference to an arrangement in which the case member had an external shape resembling that of a case holding a plurality of AA batteries, the present invention is not limited by this shape alone and may, for example, include shapes resembling those of lithium batteries for cameras or those of other battery types or configurations such as AAA, A, B, C or D type batteries. The case member may also have a shape

different from that of a battery and be mounted separately from the electrical equipment.

Although the above embodiment was described with reference to a case in which the power supply was provided separately from the AC generator, the AC generator may also be provided as an integral component in the manner shown in FIG. **7**. This arrangement dispenses with the need for the two input terminals, but third and fourth output terminals **44***a* and **45***a* for connecting the lamp control unit **18***a* and delivering an AC output are provided in addition to the first and second output terminals **44** and **45**.

Although the above embodiment was described with reference to a case in which a capacitor was used as a storage element, it is also possible to use a nickel-cadmium battery, lithium ion battery, or other secondary battery.

Although the above embodiment was described with reference to a case in which the first and second switch circuits **60** and **61** of the constant-voltage output means were disposed at positions near the input terminal **40** of the diodes **50** and **51** in the manner shown in FIG. **5**, the arrangement and number of these switch circuits are not limited to those adopted in the embodiment. Specifically, the switch circuits can be disposed at positions indicated by the triangle, square, or circles in FIG. **8**. Here, the circles indicate the positioning of switch circuits between the storage elements **52** and **53** and the diodes **50** and **51** in accordance with a reverse arrangement relative to the above embodiment. In addition, the square and triangle indicate the positioning of switch circuits between the first input terminal **40** and the bifurcation point between the first input terminal **40** and the diodes **50** and **51**, and between the second input terminal **41** at the bifurcation point between the storage elements **52** and **53**. A single switch circuit (e.g., square or triangle) can be used when it is positioned facing the input terminal at the bifurcation point in such a manner. Another feature of the present embodiment is that the lamp control unit **18***a* is arranged in parallel with the shift controller **9** rather than with the AC generator.

Although the above embodiment was described with reference to a case in which the first and second switch circuits **60** and **61** were switched off by the switch circuit **62** when the output voltage exceeded the first prescribed voltage, it is also possible to adopt an arrangement in which the first and second switch circuits **60** and **61** are subjected to Pulse Width Modulation (PWM) control and the first prescribed voltage is maintained.

The size, shape, location or orientation of the various components may be changed as desired. The functions of one element may be performed by two, and vice versa. It is not necessary for all advantages to be present in a particular embodiment at the same time. Every feature which is unique from the prior art, alone or in combination with other features, also should be considered a separate description of further inventions by the applicant, including the structural and/or functional concepts embodied by such feature(s). Thus, the scope of the invention should not be limited by the specific structures disclosed or the apparent initial focus on a particular structure or feature.

What is claimed is:

1. A bicycle power supply circuit whereby an AC voltage from an AC generator mounted on a bicycle is converted to a DC voltage, and the converted DC voltage is provided to an electrical component on the bicycle, the bicycle power supply circuit comprising:

a first input terminal for connecting to a first AC generator output terminal of the AC generator;

a second input terminal for connecting to a second AC generator output terminal of the AC generator;

a first output terminal for connecting to the electrical component;

a second output terminal for connecting to the electrical component;

a full-wave voltage rectifier circuit that converts AC voltage presented at the first and second input terminals into a DC voltage;

a storage device coupled to the voltage rectifier, wherein the storage device includes first and second serially coupled capacitance elements forming a positive voltage terminal and a negative voltage terminal;

wherein the positive voltage terminal is coupled for providing a positive voltage signal to the first output terminal;

wherein the negative voltage terminal is coupled for providing a negative voltage signal to the second output terminal; and

a voltage regulator that regulates the voltage across the first and second output terminals at a prescribed value, wherein the voltage regulator comprises:

a switch disposed between the first input terminal and the storage device; and

a switch control circuit coupled to the switch, to the first output terminal and to the second output terminal and adapted to sense a voltage across the first and second output terminals and to selectively switch the switch to an off state.

2. A bicycle power supply circuit whereby an AC voltage from an AC generator mounted on a bicycle is converted to a DC voltage, and the converted DC voltage is provided to an electrical component on the bicycle, the bicycle power supply circuit comprising:

a first input terminal for connecting to a first AC generator output terminal of the AC generator;

a second input terminal for connecting to a second AC generator output terminal of the AC generator;

a first output terminal for connecting to the electrical component;

a second output terminal for connecting to the electrical component;

a full-wave voltage rectifier circuit that converts AC voltage presented at the first and second input terminals into a DC voltage;

a storage device coupled to the voltage rectifier, wherein the storage device has a positive voltage terminal and a negative voltage terminal;

wherein the positive voltage terminal is coupled for providing a positive voltage signal to the first output terminal;

wherein the negative voltage terminal is coupled for providing a negative voltage signal to the second output terminal; and

wherein the voltage rectifier comprises:

a first diode having an anode and a cathode;

a second diode having an anode and a cathode;

wherein the anode of the first diode is coupled to the first input terminal;

wherein the cathode of the second diode is coupled to the first input terminal;

a first storage element having a first terminal coupled to the cathode of the first diode and a second terminal coupled to the second input terminal; and

a second storage element having a first terminal coupled to the anode of the second diode and a second terminal coupled to the second input terminal.

3. The circuit according to claim **2** further comprising a voltage regulator that regulates the voltage across the first and second output terminals at a first prescribed value.

4. The circuit according to claim **3** wherein the voltage regulator regulates the voltage across the first and second output terminals to less than twice the voltage across the first and second input terminals.

5. The circuit according to claim **3** wherein the voltage regulator comprises:

a first switch disposed between the first input terminal and the first diode;

a second switch disposed between the second input terminal and the second diode;

a switch control circuit coupled to the first switch, to the second switch, to the first output terminal and to the second output terminal and adapted to sense a voltage across the first and second output terminals and to selectively switch at least one of the first switch and the second switch to an off state.

6. The circuit according to claim **5** wherein the voltage regulator selectively simultaneously switches both the first switch and the second switch to an off state.

7. The circuit according to claim **5** wherein the switch control circuit causes at least one of the first switch and the second switch to effect pulse width modulation of the signal received by the first input terminal.

8. The circuit according to claim **5** wherein the voltage regulator comprises a third switch for switching off a signal at at least one of the first and second output terminals.

9. The circuit according to claim **8** wherein the voltage regulator switches the third switch to an off state when a voltage across the first and second output terminals is less than a second prescribed value.

10. The circuit according to claim **9** wherein the first prescribed value is greater than the second prescribed value.

11. The circuit according to claim **3** wherein the voltage regulator comprises a switch for switching off a signal at at least one of the first and second output terminals.

12. The circuit according to claim **11** wherein the voltage regulator switches the switch to an off state when a voltage across the first and second output terminals is less than the first prescribed value.

13. The circuit according to claim **2** wherein the first diode is the only diode directly connected to the first storage element, and wherein the second diode is the only diode directly connected to the second storage element.

14. The circuit according to claim **2** wherein the first storage element comprises a first capacitor, and wherein the second storage element comprises a second capacitor.

15. The circuit according to claim **2** wherein the first storage element comprises a first battery, and wherein the second storage element comprises a second battery.

16. A bicycle power supply circuit whereby an AC voltage from an AC generator mounted on a bicycle is converted to a DC voltage, and the converted DC voltage is provided to an electrical component on the bicycle, the bicycle power supply circuit comprising:

a first input terminal for connecting to a first AC generator output terminal of the AC generator;

a second input terminal for connecting to a second AC generator output terminal of the AC generator;

a first output terminal for connecting to the electrical component;

a second output terminal for connecting to the electrical component;

a full-wave voltage rectifier circuit that converts AC voltage presented at the first and second input terminals into a DC voltage;

a storage device coupled to the voltage rectifier, wherein the storage device has a positive voltage terminal and a negative voltage terminal;

wherein the positive voltage terminal is coupled for providing a positive voltage signal to the first output terminal;

wherein the negative voltage terminal is coupled for providing a negative voltage signal to the second output terminal; and

a case member having a shape corresponding to a commercially available battery case, wherein the full-wave voltage rectifier circuit and the storage device are disposed in the case member, wherein the first output terminal is located at a position corresponding to a first terminal of the commercially available battery case, and wherein the second output terminal is located at a position corresponding to a second terminal of the commercially available battery case.

17. The circuit according to claim **16** wherein the first input terminal and the second input terminal are located on an external surface of the case member and spaced apart from each other.

18. The circuit according to claim **16** wherein the case member has a shape corresponding to a lithium battery case.

19. The circuit according to claim **16** wherein the case member has a shape corresponding to a commercially available battery case containing a plurality of aligned batteries selected from the group consisting of an AAA battery, an AA battery, an A battery, a C battery and a D battery.

20. A bicycle power supply circuit whereby an AC voltage from an AC generator mounted on a bicycle is converted to a DC voltage, and the converted DC voltage is provided to an electrical component on the bicycle, the bicycle power supply circuit comprising:

a first input terminal for connecting to a first AC generator output terminal of the AC generator;

a second input terminal for connecting to a second AC generator output terminal of the AC generator;

a first output terminal for connecting to the electrical component;

a second output terminal for connecting to the electrical component;

a fall-wave voltage rectifier circuit that converts AC voltage presented at the first and second input terminals into a DC voltage;

a storage device coupled to the voltage rectifier, wherein the storage device includes first and second serially coupled capacitance elements forming a positive voltage terminal and a negative voltage terminal;

wherein the positive voltage terminal is coupled for providing a positive voltage signal to the first output terminal; and

wherein the negative voltage terminal is coupled for providing a negative voltage signal to the second output terminal.

21. The circuit according to claim **20** further comprising the AC generator having the first AC generator output terminal coupled to the first input terminal and the second AC generator output terminal coupled to the second input terminal.

22. A bicycle power supply circuit whereby an AC voltage from an AC generator mounted on a bicycle is converted to a DC voltage, and the converted DC voltage is provided to an electrical component on the bicycle, the bicycle power supply circuit comprising:

a first input terminal for connecting to a first AC generator output terminal of the AC generator;

a second input terminal for connecting to a second AC generator output terminal of the AC generator;

a first output terminal for connecting to the electrical component;

a second output terminal for connecting to the electrical component;

a full-wave voltage rectifier circuit that converts AC voltage presented at the first and second input terminals into a DC voltage;

a storage device coupled to the voltage rectifier, wherein the storage device includes first and second serially coupled capacitance elements forming a positive voltage terminal and a negative voltage terminal;

wherein the positive voltage terminal is coupled for providing a positive voltage signal to the first output terminal;

wherein the negative voltage terminal is coupled for providing a negative voltage signal to the second output terminal;

a voltage regulator that regulates the voltage across the first and second output terminals wherein the voltage regulator comprises:

a switch for switching off a signal to at least one of the first output terminal and the second output terminal; and

a switch control circuit coupled to the switch, to the first output terminal and to the second output terminal and adapted to sense a voltage across the first and second output terminals and to selectively switch the switch to an off state when a voltage across the first and second output terminals is less than a prescribed value.

* * * * *

United States Patent [19]

Copeland

[11] **Patent Number: 5,015,918**

[45] **Date of Patent: May 14, 1991**

[54] **BICYCLE SINGLE-WIRE LIGHTING SYSTEM WITH STEADY-FLASHING-REFLECTOR REAR WARNING DEVICE**

[76] Inventor: **John Copeland,** 1230 Alameda De Las Pulgas Apt. 3, Belmont, Calif. 94002

[21] Appl. No.: **402,123**

[22] Filed: **Aug. 31, 1989**

Related U.S. Application Data

[63] Continuation of Ser. No. 223,297, Jul. 22, 1988, abandoned, which is a continuation of Ser. No. 825,380, Feb. 3, 1986, abandoned.

[51] **Int. Cl.**^{5} **H01K 7/00; H05B 41/14**

[52] **U.S. Cl.** **315/76;** 315/179; 362/72; 362/227

[58] **Field of Search** 315/75, 76, 77, 78, 315/179, 182, 190, 312; 362/72, 227, 228, 800

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,779,629	12/1973	Green	350/103
4,323,879	4/1982	Kelley	340/134
4,388,559	6/1983	Lefavour	315/78

OTHER PUBLICATIONS

David Sellers, "Reflectors and Reflective Materials", Bike Tech, Jun. 1985, vol. 4, No. 3, pp. 7-13.

Stanley Electric Co., 2-9-13, Nakameguro, Meguro-Ku, Tokyo, Japan.

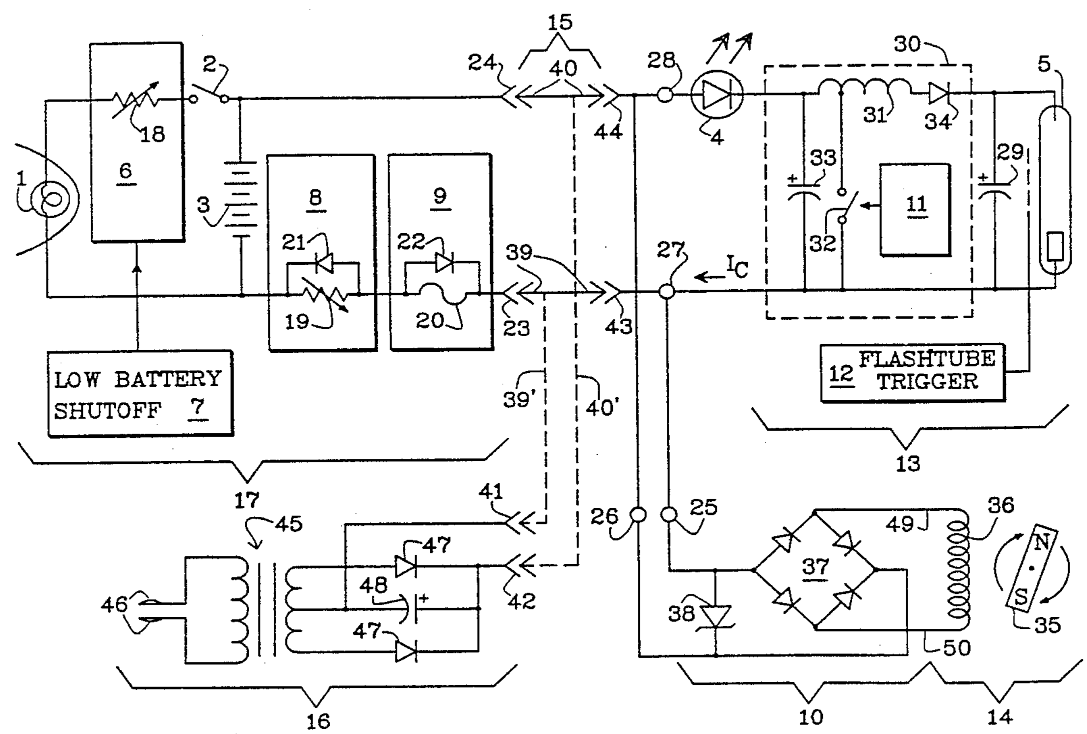
Wesley Iversen, "Would You Believe LED Brake Lights", Electronics, Sep. 18, 1986, p. 36.

Primary Examiner—Eugene R. LaRoche
Assistant Examiner—Ali Neyzari
Attorney, Agent, or Firm—Robert R. Keegan

[57] **ABSTRACT**

Red LEDs having sufficient brightness and efficiency are employed for a bicycle tail lamp. A xenon strobe provides extended visibility over the steady red LED beam, identifiable as a vehicle tail lamp; dispersed high intensity flashes of the strobe may be seen directly or observed as reflections from the surroundings. The flash is powered from the difference between the supply potential and that required by the LEDs so the current through the LEDs is controlled without wasting power or adding unproductive circuitry. These elements are located in a retro-reflector similar to that in common use on bicycles to form a warning device that is small, easy to mount, with an uncomplicated electrical hookup; a simplified parallel connection scheme needs only a single wire in addition to the metal bicycle frame. The system has the rechargeable battery and the generator substantially in parallel; generator power is used when the bicycle is in motion and battery power when stopped. The interconnecting wiring system assures the operation of the rear warning device from the generator should the headlamp be missing or disconnected with the rate of the omnidirectional flashes increased and is a partial substitute to the warning that the headlamp would normally provide.

22 Claims, 5 Drawing Sheets



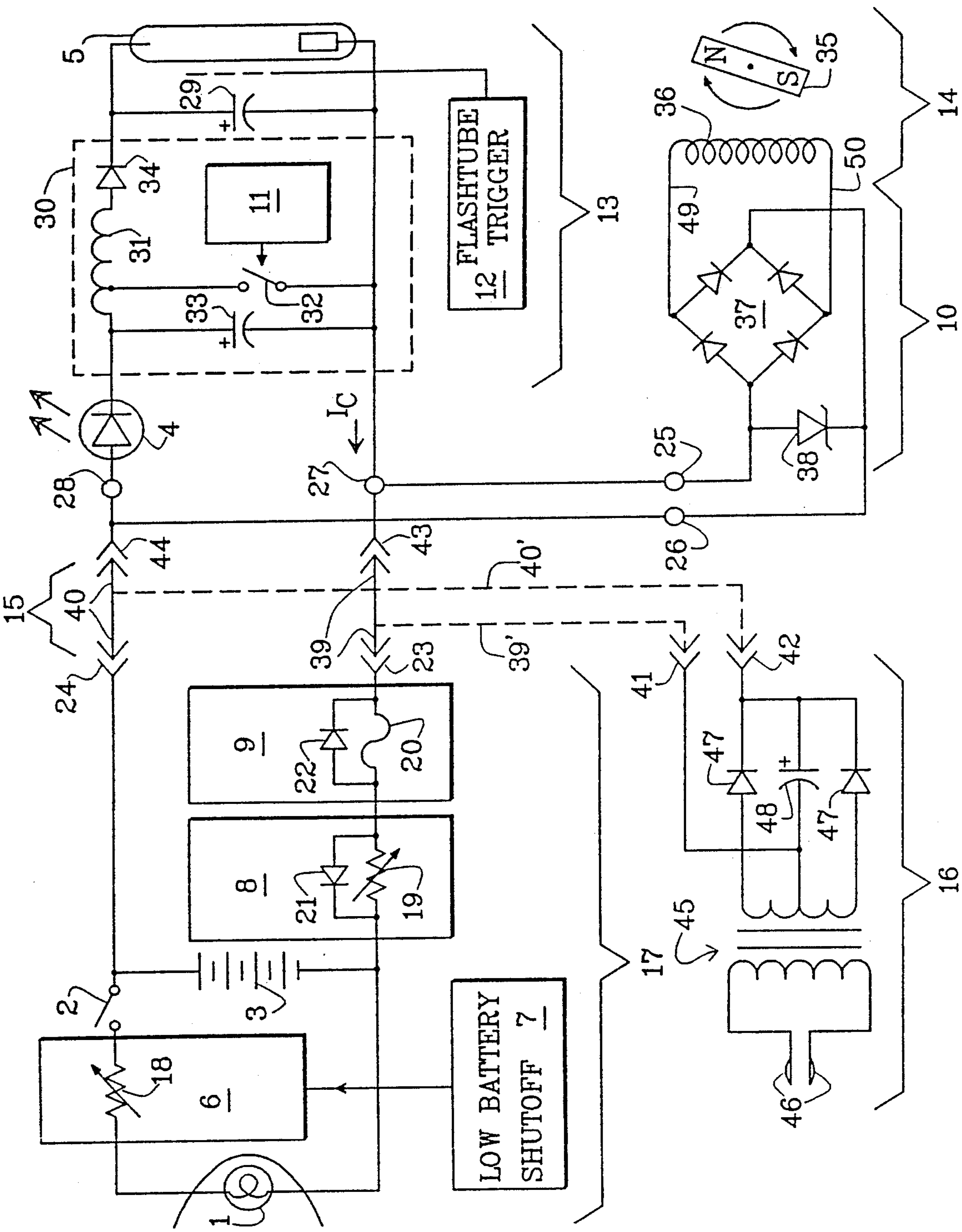


FIG. 1

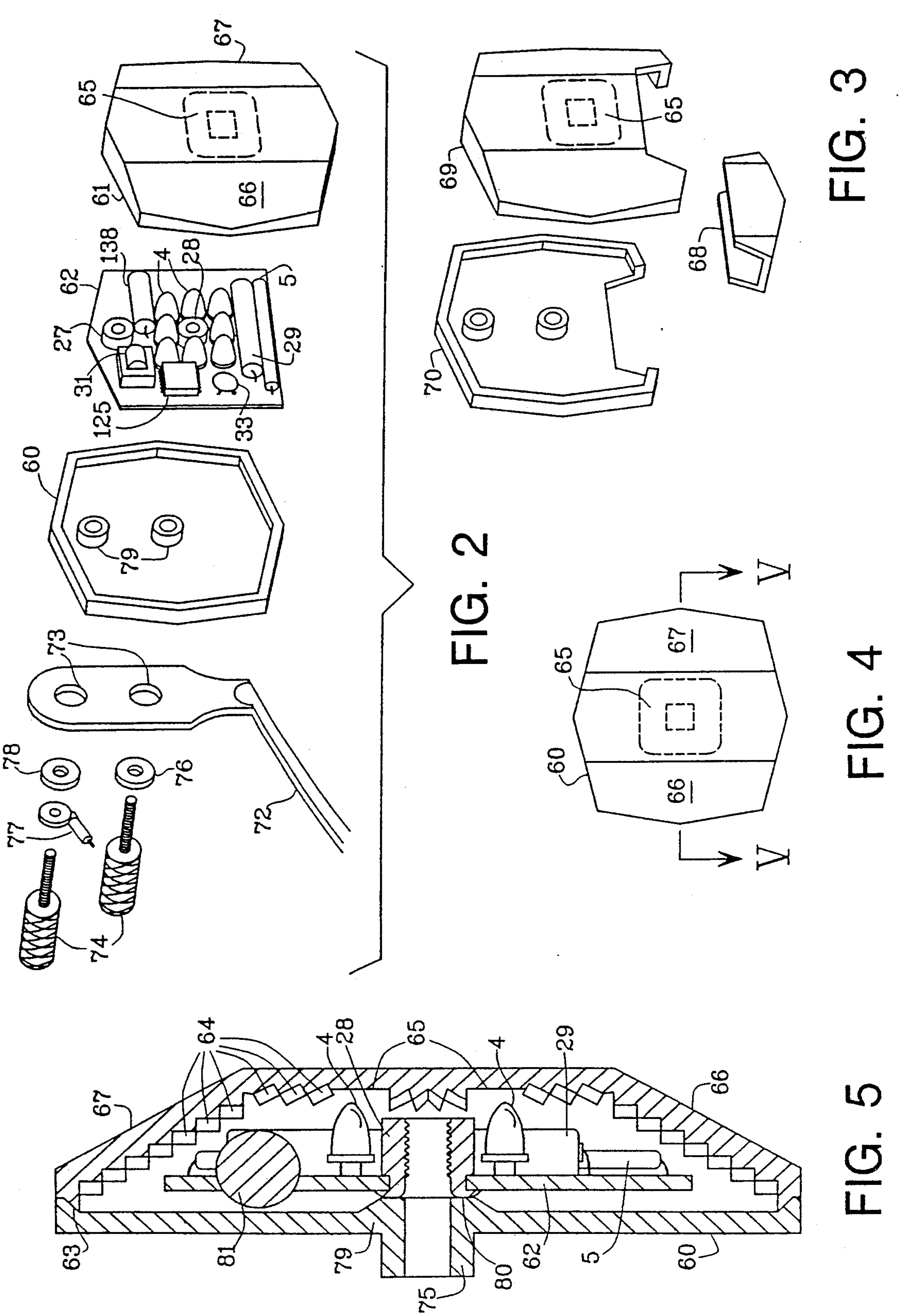


FIG. 2

FIG. 3

FIG. 4

FIG. 5

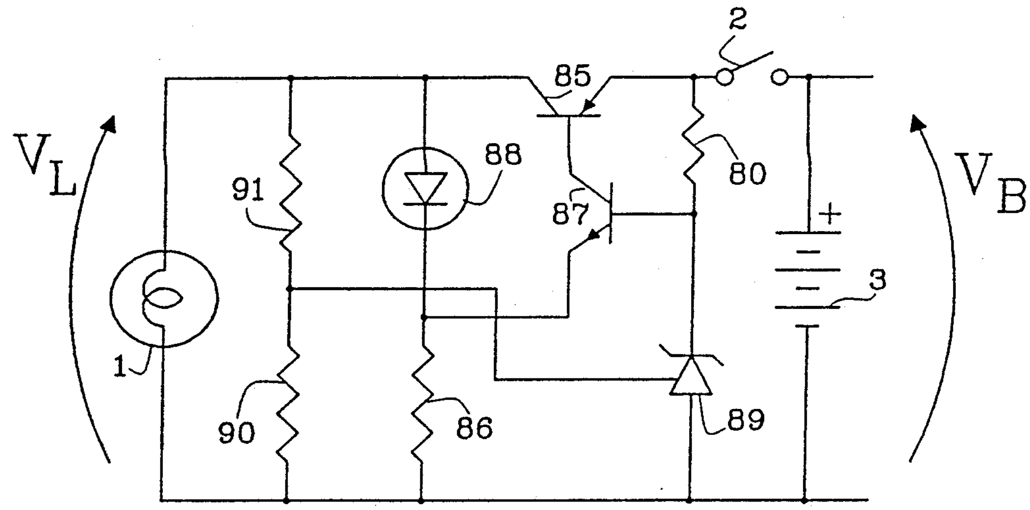


FIG. 6

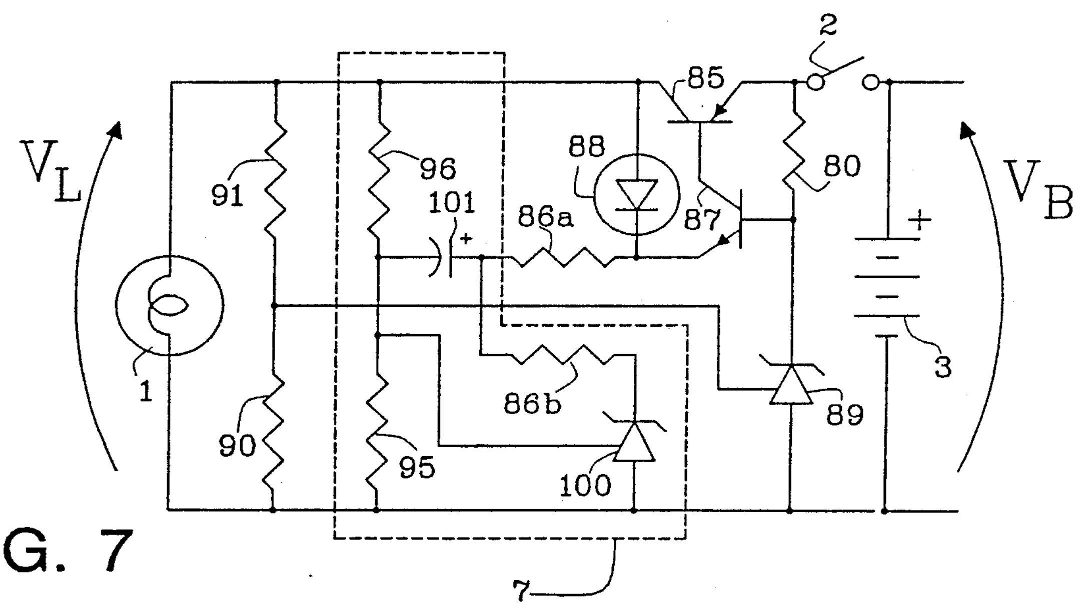


FIG. 7

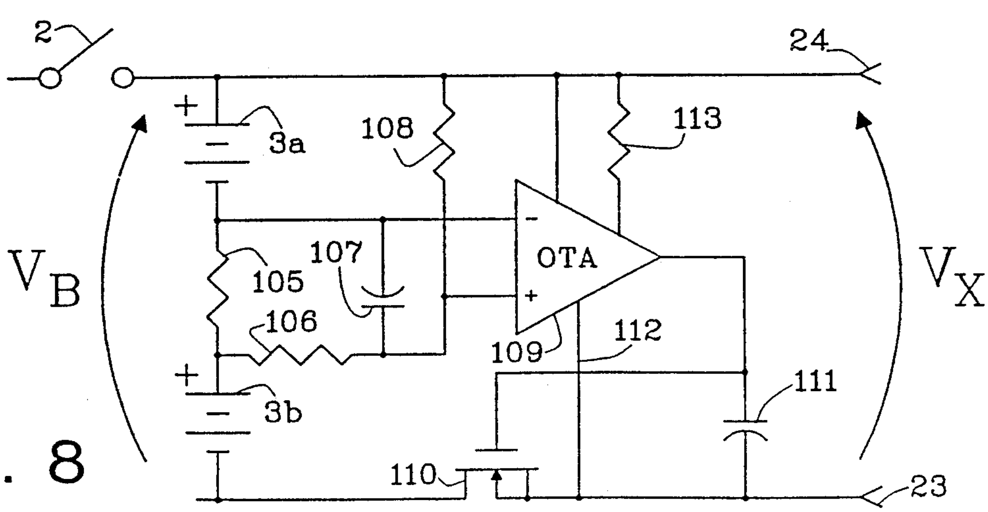


FIG. 8

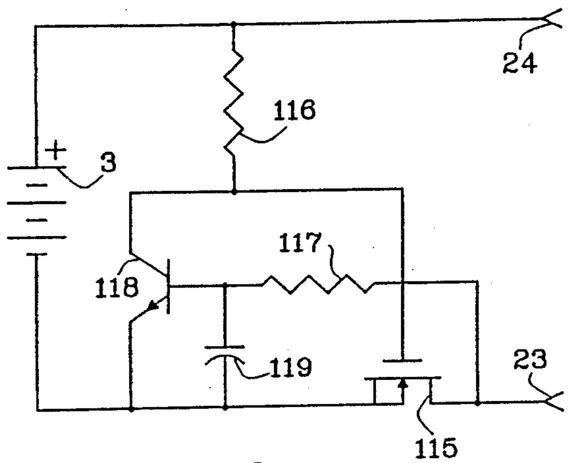


FIG. 9

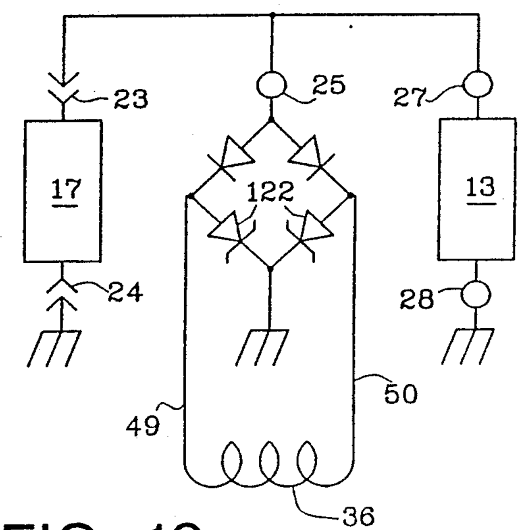


FIG. 10

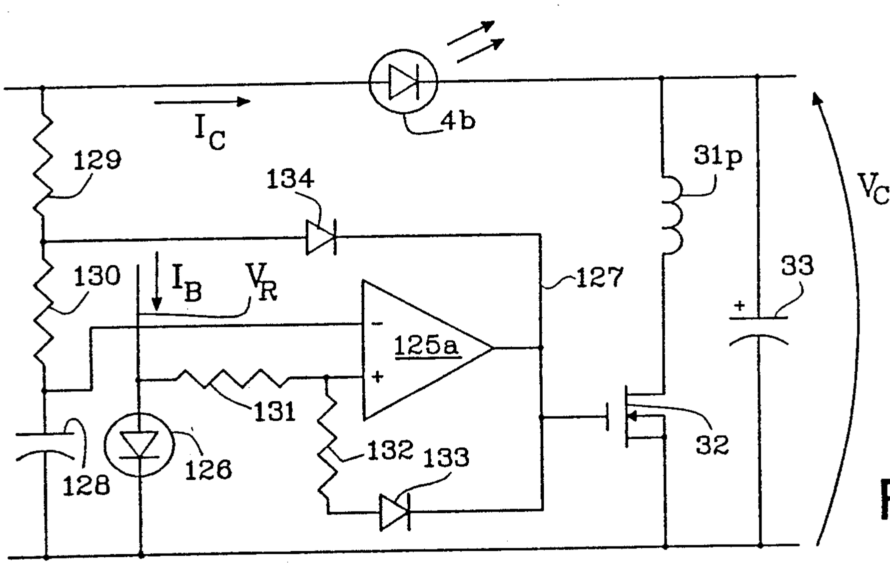


FIG. 11

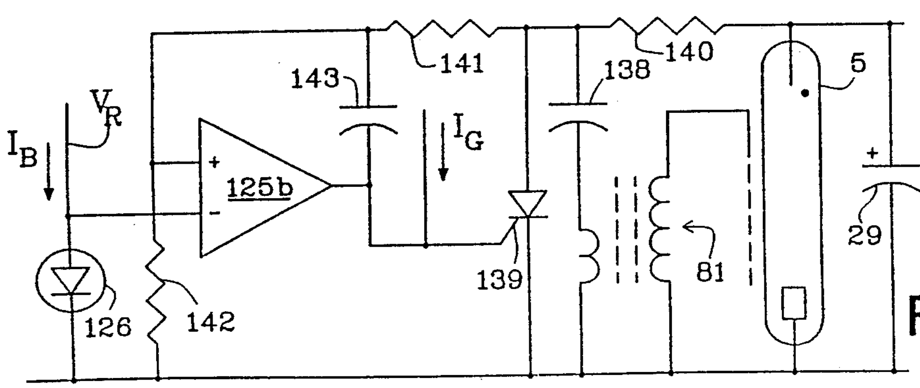
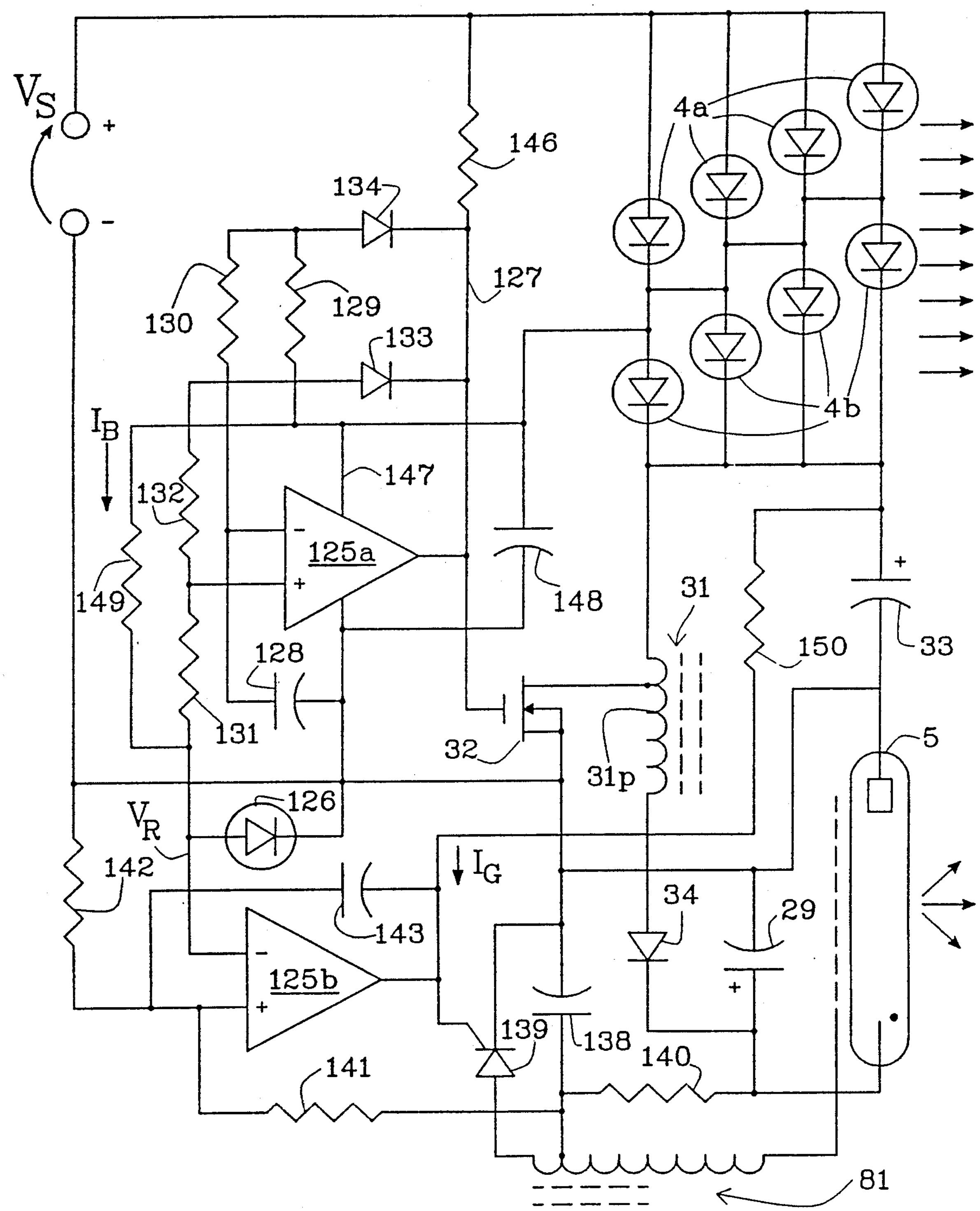


FIG. 12


V_S
+
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146
134
127
130
129
133
4a
4b
I_B
132
147
125a
149
148
31
150
33
128
131
32
31p
5
126
V_R
142
I_G
143
34
29
125b
139
138
140
141
81

FIG. 13

BICYCLE SINGLE-WIRE LIGHTING SYSTEM WITH STEADY-FLASHING-REFLECTOR REAR WARNING DEVICE

This application is a continuation of application Ser. No. 07/223,297, filed July 22, 1988, now abandoned, which was a continuation of application Ser. No. 06/825,380, filed Feb. 3, 1986, now abandoned.

FIELD AND BACKGROUND OF THE INVENTION

The field of the invention is that of reflectors, warning lights and illumination lights together with their interconnection system as used by pedestrians and on bicycles or other small vehicles.

Present day vehicle tail lights utilize an incandescent filament bulb inside a mirrored cavity with a red lens covering the assembly. The mirrored surface is utilized to direct a substantial amount of light into a relatively narrow angle beam corresponding to the direction of the approach of following vehicles. Additionally, the lens gives the light its recognizable red color. Power for the lamp, in the case of a bicycle, is commonly from a 3 watt generator energized by way of the rotation of a wheel and is portioned 0.6 watts for the tail lamp and the remainder for the headlamp. However, this is in stark contrast to the automobile where just one side of its system would typically use ten times this amount of power.

Mechanically, the typical bicycle requires one-tenth of a horsepower from its rider for a speed of 12 mph and this is the equivalent of 75 electrical watts. Tests on the drag created by bicycle generators and published in the literature indicate that they require the equivalent of 15–33 watts additional effort, or 20–44% of the 12 mph effort—a considerable amount. In order to minimize size and weight, a properly designed generator would maximize the output power which implies that the electrical power lost internally and the power lost to mechanical drive coupling would equal the power delivered to the light system. Hence an improved generator which produced 30 watts of drag would have an output power of 10 watts. While this might be a significant improvement, this is still drastically less than the power typically involved in motorcycles and automobiles. Additionally the generator powered light system also has a serious drawback in that the lights are out when the bicycle is stopped and this can be a situation in which they are most needed for safety.

There has been some attempt to use rechargeable batteries to provide the power rather than relying on what can be conveniently generated by the rider, however in the prior art the result has been a system which is bulky and expensive, as well as inconvenient to mount and maintain. These are most generally useful to commuting cyclists whose schedule and need for lighting are non-varying rather than for the casual or juvenile cyclist. Systems which use dry batteries are relatively inexpensive and are convenient to mount and maintain by casual or juvenile cyclists; on the other hand, lights powered by dry batteries are usually of low power to obtain longer service life which makes them much less conspicuous and less safe.

Retro-reflectors, which operate to redirect the light from a source back to the source but do not have to be exactly aligned as would a mirror, require no power from the vehicle on which they are mounted for operation and by utilizing the higher intensity headlamps of an approaching vehicle can under usual conditions be seen at the necessary distances. Thus they are required by the governing authorities for night riding and also are generally accepted by the bicycling population. The ones commonly in use today are molded of a transparent plastic but have a translucent color of red for the rear, amber for the pedal positions and crystal meaning colorless for the front. They are smooth on the side facing in the direction of the light to be reflected which makes for easy cleaning, the other side having a pattern of multiple cube corners. This patterned side which causes the retro-reflection is protected from dirt and moisture condensation by a second molded piece which is glued to the first and forms an isolated air space.

The CPSC (Consumer Product Safety Commission) has set minimum standards for the reflectors that can and must be used on bicycles sold and used in the United States. This has resulted in the development of a very inexpensive unit which is rugged and not overly large owing to improvements in the manufacture of cube-corner retro-reflectors. The CPSC requirements ensure that the various approach angles of bicycle and automobile are taken care of through the specification of performance at large angles of retro-reflector horizontal orientation while mounting is held to a maximum of 5 degrees either up or down in the vertical. Because of the relatively large flat area of the face of the retro-reflector it is not unreasonable to expect the average cyclist will be able to maintain his retro-reflectors in a suitable orientation with only casual observation of their mounting position relative to the bicycle frame.

Helmut Zwahlen on the basis of studies performed at Ohio University has proposed that bicycle tail lamp requirements be adopted which dictate a two candlepower output for a red beam which spans 20 degrees in the vertical orientation and 40 degrees in the horizontal. He theorizes that such requirements could be met with a highly efficient sealed beam approach that would consume one watt of electrical power. He bases the two candlepower requirement on test results which indicate that a point light source tail lamp needs to be 1000 times brighter than minimum detectable brightness for laboratory type conditions of a uniform background with uniform illumination. The applicant has tested, to determine typical values, the rear tail lamp of three present day better quality bicycle generator sytems and found that they project rectangular shaped beams which have about 20 degrees of horizontal dispersion and 11, 13 and 20 degrees of vertical. Unlike the retro-reflector the orientation of the housing by casual inspection is much less satisfactory and the proper method is to energize and project the tail lamp onto a wall so that the mounting can be adjusted to make the height of the projected beam the same as the mounting height of the lamp on the bicycle. A task which is complicated by the lack of generator output when the bicycle is stationary. Given the average cyclist's unwillingness to give much consideration to lighting systems which are typically used infrequently, it seems unlikely tail lamps with precisely focused beams represent an adequate solution.

If a motor vehicle is following another motor vehicle, the driver may or may not be aware of a vehicle ahead of the one he is following. However because he will soon pass a slower moving bicycle, he does need to be aware of a rider along the edge of the road whose retro-reflector and tail light may be obscured by the motor vehicles ahead of his own. Clearly if safety were the

only requirement then the system which appears in U.S. Patents in abundance would also be commonplace on our streets. These systems place an omnidirectional light source above the rider at a height sufficient to be seen above adjacent automobile traffic, this usually being accomplished by a pole attached to the rear of the bicycle. One of these by Lewis (U.S. Pat. No. 4,088,882) offers substantially increased light output through the use of a flourescent bulb, even when compared to the new halogen type incandescent.

But power alone does not ensure conspicuity. Motorcycles, which have lights of comparable power to automobiles, have long been plagued by motorists making left turns into their path. A device which modulates the headlamp beam with a low frequency to make it more noticeable has recently been found to be effective in this situation. It seems that the dual lamp system and the presence of an unlighted but visible body provide important spatial recognition factors for the automobile and hence spatial factors must also be generated for bicycles if they are to have adequate conspicuity.

Flashing lights have been used on bicycles to increase their conspicuity while minimizing power consumption. However there have been problems in the prior art in that the cyclist naturally seeks to minimize his burden and has operated such devices in lieu of a red rear tail lamp. This has led to criticisms that the cyclist may be mistakenly identified, at least at first sighting, as a construction barricade and that the cyclist's position is difficult to keep track of during the interval between flashes. The flash rate is typically in the range of once a second and they utilize either an incandescent lamp or a gas filled flash tube.

When an incandescent lamp is used, it has a relatively higher power rating since it is operating with a low duty cycle. Additionally an inrush of current is necessary in order to heat the filament to incandescence. Thus it is usually necessary to power such a flasher from batteries, either dry or rechargeable, to provide the high peak power called for.

When a gas filled flashtube is used, the energy for the subsequent flash is first stored in a high voltage capacitor. Thus it is possible for this type of device to be powered from a generator where the peak power is limited. This approach is more complex however because it requires a voltage converter to transform the low input voltage by a factor of a 100 or more times to the potential needed by the flash tube. The least expensive and most common type of voltage converter uses a transformer with a high turns ratio. A pair of transistors in a self-driven arrangement connect the DC input voltage to the primary first with one winding polarity and then with the opposite winding polarity, while the alternating voltage on the secondary is rectified to charge the storage capacitor. Since the current is limited only by the resistances in the circuit this type of converter is not very efficient. And the current draw from the source is quite heavy for the time immediately following a flash when the voltage potential of the storage capacitor is lowest. When this circuit is used in battery powered strobes, the flash rate becomes much slower as the battery is progressively consumed since the voltage conversion ratio is fixed by the transformer turns ratio.

Although the flashtube may be designed to flash when the voltage impressed upon it reached a critical value, better efficiency and longer life result from the customary design of the flashtube which requires a separate trigger circuit to initiate the flash. Energy is first stored in a smaller trigger capacitor by way of a high resistance connected to the main storage capacitor. A trigger switch element then initiates the flash by discharging the trigger capacitor into the primary of a trigger coil, the secondary of which is connected appropriately to the flash tube. The trigger switch element may be a small gas filled discharge tube, however such tubes though small and easy to wire in are somewhat expensive and have a relatively high tolerance on their breakover voltage both initially and with consideration of wearout.

An inexpensive SCR (Silicon Controlled Rectifier) may be used as the trigger switch element however it requires additional circuitry to sense the high potential on the storage capacitor and provide current into its gate terminal. Because the flash tube sometimes doesn't fire when the trigger circuit is first activated, it is necessary to have the triggering repeat until the flash does occur. This is most easily accomplished by having the trigger circuit sense the voltage on the trigger capacitor rather than that on the larger storage capacitor from which it derives it's potential. This presents no problem with the previously considered gas filled trigger tube but adds complexity in the case of the SCR because of its anode leakage currents which act to set up an unwanted feedback loop through the voltage sensing circuitry that connects the SCR anode (the trigger capacitor potential) with the SCR gate. Another complication is that the breakover devices typically used in the voltage sensing circuitry require enough current from the high voltage supply as to create a significant drain of power.

Consider a comparison of two similarly priced battery powered flashers. A flashtube type of strobe unit marketed by Bike Nashbar which comes with a strap for arm mounting and the "Belt Beacon" an incandescent unit which is detailed in U.S. Pat. Nos. 4,047,150 and 4,323,879 by Kelley. The "Belt Beacon" uses a 9 volt transistor battery which is necessary in order to make use of a bulb with a low current rating which has less mass and will heat up quickly, while the strobe uses an C-cell flashlight battery which costs less and contains more energy. The housing of the "Belt Beacon" is sealed against dust and the printed circuit board has a wax dip to protect it from moisture. In the strobe, all of the electronics including the flashtube are cast in a hemisphere of clear resin to seal out moisture and make a rugged mechanical structure. Since the cast plastic hemisphere is no larger that the C-cell, the circuit used must be quite simple and compact. When the batteries are fresh the flash rate of the strobe is about once a second, this increases to seven second intervals when the batteries become exhausted.

While in the prior art it might have been regarded as a minimal burden by non-cycling persons, the need to provide for separate mounting and replacement batteries has been as significant as their price in detering their use as a standard conspicuity measure amoung the casual bicycling public.

The flyback mode of converter circuit which is theoretically efficient has been used in DC to DC conversion for products demanding higher quality. On a repetitive basis, energy from the source is first stored in an inductor and then relased at a higher potential to the storage capacitor. The self-oscillating type which is simplest, has been detailed in U.S. Pat. No. 4,388,559 by LeFavour for use on bicycles. The flyback converter does have a variable ratio step-up; however, the self-

oscillating type draws increased current from the supply if its input voltage is increased and in the time immediately following a flash it will draw a decreased amount of current owing to a lengthening of the oscillation period. Driven types of flyback converters which could eliminate these drawbacks, have in the prior art been too expensive for a bicycle application suitable for a large number of the population.

Externally powered flashers have been offered as options in the deluxe systems intended for the commuting cyclist. However, flashers meant to operate on an arbitrary source potential of the customers choice have not been available. For reasons stated previously, the flasher operating characteristics are usually dependent on the powering source voltage and impedance which are in turn dependent on the particular battery type and/or generator employed. Additionally it is customary for these systems to employ polarized connectors in the interconnections to prevent the application of reverse potentials which could damage the electronic portion of either type of flasher. Since there is no standardization of connectors or electrical power sources, this limits the use of such devices in other systems, at least for the non-technically minded casual cyclist.

It has been reported that the Swedish company, Wilhelmina Plast, is making a bicycle mostly from plastic materials and is utilizing LEDs (Light Emitting semiconductor Diodes) for the tail light, powered by batteries located in the frame. LEDs bright enough for this purpose represent an advance in semiconductor technology and have been commercially available for a considerable number of years. Such devices have the necessary beam focusing inherent in their package design and emit monochromatic light, thus not needing filters which reduce efficiency, They are available in deep red which is advantageous since it is more recognizable to motorists than the filtered incondescent, which will necessarily appear more orange-ish. When operated within their ratings, the LEDs are very long lived and are not subject to breakage from shock as is the filament of low current bulbs.

However, there are no present commercial applications of such LED devices to bicycle tail lamps in the United States. This is because the only significant advantages of the LED lies in it's inherent deep-red color output and its longevity. These are not very significant compared to a cost of 5–10 times that of an incandescent and the mood of the bicycling community today which desires improved conspicuity for such a sizeable increase in cost.

The electrical design problems inherent in the utilization of LEDs are also numerous. A single large device is with present technology impractical and thus several smaller devices must be grouped together for high outputs. When current is applied each diode produces a nearly constant voltage drop depending mostly on the particular device construction and ranges from 1.7 to 2.5 volts. This necessitates the series connection of two or three devices to avoid wasting the power available from the source. Furthermore, if only a resistor is used to limit the current, then slight voltage changes due to battery use or fluctuations in the generator speed will cause large variations in current, which is highly undesireable. It also must be considered that the LEDs operate with current of one direction only, and this creates further problems if they are to be powered from the wheel driven generator which produces alternating current.

Even if these various known known lighting methods could provide adequate conspicuity, individuals who have attempted to simultaneously use the various known visual warning devices in order to overcome the inadequacies inherent in the use of any one alone, have been derisively called "Christmas tree advocates." However, Helmut Zwahlen has performed an experiment which shows that two reflectors spaced at a distance from each other are more conspicous than a single reflector of the combined area. In the case of the pedal reflectors which are currently part of the CPSC mandated system, there is little inconvenience involved. But in general, multiple deployment has been regarded as too much trouble by the casual and serious cyclist alike. While this opinion may not be well founded, it points to the failure of the prior art to provide a practical and convenient system that is effective in solving a complex conspicuity problem but involves only a few simple to use pieces suitable also for installation and maintenance by casual cyclists and juveniles.

Minimizing the number and mounting complexity of the required pieces of the system is important both to the serious cyclist, who is likely to completely remove the system during periods when it is not needed in an effort to reduce the weight of the bicycle and improve its appearance, and to the casual cyclist who needs to have reliability with as little amount of maintenance as possible. Plastic parts, particularly the headlight lens setup, deteriorate significantly with prolonged exposure to direct sunlight and the other elements. This dictates that some removal of components pieces should be anticipated even for the casual cyclist and is currently one of the limitations of the well known generator system in which the headlamp must be a securely grounded part of the system and is thus permanently fixed.

The minimum system presently kown to be necessary includes a head lamp for illuminating the roadway, a rear warning lamp, connecting wires and the red rear facing reflector which is required by the CPSC. It is desireable to include the option of a generator in this concept of a minimum system to provide for extended periods of operation and for partial operation when the batteries are absent or discharged. Although significant improvements in batteries may be on the horizon, the most likely result of such improvements would be to reduce the monetary cost or size of a system or to provide higher power lamps rather than providing for extended periods of operation to ensure reliability under all schedules of service.

Many otherwise suitable visual warning devices have not been given serious consideration due to their size and mounting. To the uninitiated the bicycle with its exposed tubular frame seems to offer a wealth of space and attachment points. However, only the space above the rear wheel and beneath the seat is of much practical use for rear facing devices. The sweep of the rider's legs and feet eliminate the use of the chain stays except near the rear axle; attachments to the rear axle make wheel changing difficult and many bicycles are fitted with quick release rear axle assemblies which are less adaptable than the threaded type; it is difficult to get a tight grip on the small and somewhat tapered tubes that form the rear wheel support triangle; and if the attachment slips it may interfere with the rotation of the wheel as well as scratch the paint on the frame. It must also be considered that bicycles are sometimes put on the ground on their sides which tends to damage any side attachments as well as to force them inward. If a bicycle

to be used for touring is fitted with panniers and a sleeping bag on top of the rack, then even the underseat position is blocked, and only the rear of the rack remains as suitable. This leads to the observation that the CPSC mandated rear reflector is currently being placed at the only effective but out of the way position that is available, not necessarily the position which would make it most effective since car headlights are necessarily aimed downwards, and research has confirmed that this would favor a lower mounting position.

Operation of a rechargeable battery together with a wheel driven generator is offered in a system made by Velo-Lux. This is accomplished by rectifying the alternating output of the generator with bridge connected diodes which charge the battery, while the lights are being powered directly from the battery. The headlight, the batteries and the rectifiers are packaged together in a unit which can be removed from the bicycle and utilized separately as a portable hand held lamp. Since the headlamp unit has most of the bulk, most of the weight, and most of the monetary value of the system, it can be expected that it will probably not be carried on the bicycle itself except when in use. Considering that the cyclist is not always able to anticipate his night time riding situations correctly, there will be times when the cyclist would like to be able to use the generator which is permanently mounted to power the rear lamp which is also permanently mounted in order to be afforded some degree of protection. However, this is not possible because the connections between the tail lamp and the generator are made within the head lamp unit and because the batteries are necessary in maintaining the proper voltage for the operation of the lamps.

The popular bicycle generator consists of a permanent magnet revolving from a drive roller in contact with the tread area of a tire and operating in conjunction with a soft iron magnetic assembly to produce an alternating magnetic flux linked to a coil of wire. The flux induces an alternating voltage in the coil whose magnitude and frequency are proportional to bicycle speed. Because the coil has inductance and, the impedance of this inductance increases with frequency which is in turn related to bicycle speed, it is possible for the alternating current, which flows through both the inductive impedance and the resistive load of the lamp bulbs, to be relatively independent of bicycle speed within the range of normal operation of the bicycle.

The unloaded voltage produced by the generator, however, is typically much higher than the normal operating voltage so that if the head lamp should burn out or become disconnected, the voltage impressed on the tail lamp increases markedly and will usually cause the burnout of the tail lamp in a short time. Some newer generator systems which make use of halogen bulbs have a voltage limiting zener device to limit the maximum voltage to the lamp and improve on the constant voltage characteristics of the generator within the normal range of bicycle with and hence this voltage limiting will become functional on the peaks of the sinusoid. Because the waveform changes with increased limiting, the burnout or disconnection of the headlamp will still allow a much increased effective or rms voltage to be impressed on the tail lamp.

In the generator system the current is limited by the inductance of the generator winding and no lasting harm will be done if the wire connecting the lamps should short out to the bicycle frame. With battery power, however, there is a possibility of a large flow of current which could cause permanent damage probably in the nature of burning the insulation off of the connecting wires.

In considering the design of generator-battery system such as the Velo-Lux it is seen that if the batteries are used as a reservoir as it were to regulate the voltage to the lamps, then it is desirable to have a battery with a large electrical capacity. However for the casual cyclist size, weight and cost are important requirements and these are best met with a lower electrical capacity battery. Increasing the size basically helps in maintaining the lamp voltage within 4 percent of nominal over most of the discharge curve. But it doesn't help in controlling the extremes of the the voltage which are determined by the chemistry involved in the battery. Considering a nickel-cadmium unit, the voltage at end of discharge may be 20 percent less than nominal and under charging conditions it will rise about 10 percent.

One of the consumer's main objections to rechargeable battery systems is the high initial cost coupled with the uncertainty of the lifetime of the battery pack under practical conditions. Of particular concern is the need to avoid completely discharging the battery which will cause the nickel-cadmium battery pack to lose capacity and even more rapid loss of useful life in the case of the sealed lead acid gelled cell. These cells, particularly the nickel-cadmium can be protected by removing the load when the potential of the battery pack falls below an amount dependent upon the number of the cells. Although the headlight is dimmer when the battery pack is exhausted to this potential there is still a very much usable amount of light being produced and it is not usually possible for the bicyclist to judge this condition properly by himself and to shut off the lamp. A complicating factor is that the nickel-cadium battery, does have a need to be occasionally excercised to this complete withdrawal of charge condition and regimens which continually make use of only a portion of the battery capacity as is commonly done with the lead acid cell will not give good results.

The Velo-Lux unit uses a halogen bulb and has improved brightness and efficiency when compared to prior art headlamps. Incandescent bulbs of which the halogen is the best example operate most effectively with a closely controlled voltage which is as large as can be tolerated without incurring unreasonably short life. Regulator circuits clearly are needed here but have not been provided in the prior art owing to complexity and expense. The low cost integrated circuit regulator which is used extensively in industry has a minimum voltage drop which greatly exceeds the 0.15 volts drop that can be achieved from a circuit employing discrete parts. On the other hand the discrete circuit has required calibration and has needed many parts to enable it to work effectively under two differing design conditions, namely as a voltage limiter when the input exceeds the lamp requirements and as a minimum voltage loss straight through element when the input voltage equals or drops below the desired lamp voltage.

The wiring for the Velo-Lux as representative of the art, is simple and straight-forward but not very convenient for the bicyclist. Two cables each containing two conductors are used to connect the tail lamp and the generator to the headlamp unit. As well as the previous problem of no direct generator operation of the tail lamp there are the additional problems of some confusion in having to connect two similarly shaped connec-

tors to the head lamp unit and the fact that the two cables which must be routed along the tubing are not easily removeable even though the head lamp unit is itself easily removeable. Such permanent wiring is usually objectionable to the casual as well as the serious cyclist because it is obtrusive, unsightly, difficult to install and easily damaged.

On the other hand, the wiring for the well known generator system can be accomplished rather neatly since only a single small diameter wire is used in addition to the metal bicycle frame. This allows access to the interior of the frame tubing by way of drilling of holes of sufficiently small diameter so as to not affect frame strength and is available as a standard feature on some better quality bicycles. The special connectors on the ends of the cables and the larger number of holes preclude the internal to the frame routing of the cables for the Velo-Lux or other prior art systems which require multiple cable wiring.

BRIEF SUMMARY OF THE INVENTION

It is an object of the invention to combine within a single rear warning device the steady directional monochromatic light source, which is the "recognizable red" beam of a standard rear vehicle tail lamp, with a pulsed gas discharge light source which produces a bright dispersed colorless flash (white light). This flash can be made to briefly illuminate part of the bicycle and its rider and to provide reflections from the roadway, other vehicles and nearby objects. The result being a spatial factor that can alert drivers of approaching vehicles sooner than would be possible with a reflector or red tail light alone. Conveniently in the preferred embodiment these steady and flashing sources are high efficiency red LEDs and a xenon strobe. Although the LED lacks the generally high level of brightness needed to guarantee visibility from substantial angles and distances, its barely adequate level of performance is offset in the invention by the high momentary brightness of the strobe. The rear warning device thus can be highly effective with a power requirement that does not exceed those of rear lamps presently in common use on bicycles. It is an object of the invention to provide an effective night safety device for the rear of a bicycle which requires only the minimum necessary accommodation. This minimum is currently defined in size and mounting by the CPSC mandated rear retro-reflector. Thus the invention builds the omnidirectional pulsed gas discharge light source and the steady monochromatic beamed light source within the retro-reflector shell. The previously wasted airspace now being utilized, in that the retro-reflector is discovered to provide the proper housing and protection for an electronic printed circuit assembly. The quality of the retro-reflector is not significantly compromised in this combination noting that only a small portion of the available surface need be a window for the beam of monochromatic light. Also noting that the pattern of the cube corners in the retro-reflector does not significantly affect the random dispersion of light from a gas filled flash tube located behind it because the length of the arc in the flash tube subtends a number of the cube corners of the retro-reflector. In the preferred embodiment, the plastic backing piece which is usually molded of an opaque material and the front retro-reflector portion are now made of clear material to allow an omnidirectional flash. If it is necessary to color the reflector, drastic attenuation of the flash may be avoided in an alternative housing design which has a third clear molded portion to separately enclose the gas discharge tube.

It is an object of the invention that in placing the rear warning device with its beamed light source into a housing design like that of a retro-reflector presently manufactured to CPSC requirements that the general flatness and presence of vertical lines on the unit provide a means whereby the cyclist can by casual observation its of it's mounting position adjust the beam to the proper orientation with respect to the bicycle and hence to the traffic environment. In the construction of the prefered embodiment, the LED package type can be chosen to provide for the desired degree of vertical dispersion and more than one LED can be used so that the leads of individual LEDs may be bent to provide the desired amount of horizontal beam angle, the circuit board to which the LEDs are attached conforming to the general plane of the retroreflector housing.

It is an object of the invention to provide an efficient circuit for a rear warning device which can operate effectively with widely varying source voltage, and whose current consumption is steady and does not change when the source voltage varies. An inexpensive implementation of the efficient and more manageable flyback converter of the driven type is disclosed to implement the charging circuit for the pulsed gas discharge light source. A separate oscillator circuit which drives the converter makes the period of time that the inductor draws energy from the input, an inverse relation of the input potential and it makes the time period that the inductor transfers energy to the storage capacitor, unvarying. These new design factors make the input current draw substantially independent of either the varying input or storage capacitor potentials. Thus the warning device is useable from most any source of electrical potential without much regard for the source impedance, and the device can tolerate pulsating or unsteady voltages inherent in obtaining direct current from the alternating output of a wheel driven generator. Of additional importance, this circuit makes the warning device tolerant of supply potentials that would be excessive and cause burnout in prior art rear lamps.

It is an object of the invention to eliminate the circuitry and its attendant power loss that would otherwise be necessary for controlling the current through the LED used as a beamed source of monochromatic light in a rear red vehicle tail lamp. In the invention, the input terminals of the voltage step-up charging circuit which powers the flash tube are connected in series with the LED, which may be a series and parallel combination of LEDs, so that the current through the LED and the entire unit is limited by the charging circuit. Because of the series connection, if the current is maintained constant with regard to changes in the source voltage, the LED brightness will not change, but the power to the flash tube will increase as more voltage is applied, creating in the design disclosed an increase in the flash rate rather than a change in the intensity of the flash itself.

It is an object of the invention to provide a circuit for a rear warning device which makes use of the diode blocking action of the LED to prevent damage in the situation of the warning device being incorrectly connected to the supply in opposite fashion by the cyclist.

It is an object of the invention to disclose a warning device that has all active electrical parts on a single circuit board without parts mounted to the case, subassemblies or loose wiring. Not only does this make the

device easier to manufacture, but it also makes it easy for the user to replace the plastic case himself should this become necessary because of scratches or cracking from rough handling that is to be expected in the rather exposed position on a bicycle where it must be mounted.

It is an object of the invention to disclose a simple, low cost trigger circuit for gas filled flashtubes by employing an integrated circuit differential comparator. The invention uses the output of the comparator to effectively short the gate junction of an SCR to reduce its anode leakage currents. A capacitor is also added between the output of the comparator and its non-inverting input which is in turn connected to the tap of a resistive divider that monitors the potential on the trigger capacitor which is supplied from the potential on the high voltage storage capacitor. This added capacitor introduces positive feedback in a precise and controlled manner to effectively eliminate the troublesome condition of the prior art when the storage capacitor potential neared the point of triggering and the leakage of current through the SCR anode created unwanted feedback and hence unreliable operation. Moreover this added capacitor shunts noise signals to ground and thereby enables the use of very large value resistances in the divider for minimum power loss.

It is an object of the invention to provide a method of attachment for the rear warning device which can be accomplished quickly and easily. This additionally will allow the bicyclist to remove the unit and carry it with him which may be necessary for instance to prevent theft. The mechanical and electrical connections are combined in the novel method disclosed which is made to permit the use of the mounting presently in use by several reflector manufacturers so that the invention may at the discretion of the cyclist be fitted to existing support brackets.

It is an object of the invention to provide a rechargeable headlamp unit employing only a single connector to provide both for recharging and/or the simultaneous operation of the rear warning device, thereby making its use simple and unconfusing. This is accomplished in the invention by placing the rechargeable batteries and the generator substantially in parallel.

It is an object of the invention to disclose a bicycle lighting system including headlamp, rear warning device, rechargeable batteries and generator which allows a simple two conductor parallel connection system and which permits partial operation when some of the pieces are not installed or absent. In the prefered embodiment, a generator with rectified output allows a single wire connection system using the frame as ground and is suitable for hidden wiring in better quality bicycles, as was the simple generator wiring of the prior art. An alternative arrangement, which could use the customary frame connecting alternating current generator, connects the headlamp, with a removeable two conductor cable, to a rectifier unit permanently mounted in the out of the way position, such as behind the rear warning device or near the generator that in present manufacture is mounted just back of the bottom bracket which is the portion of the frame holding the bearings for the pedal cranks axle. Conveniently, the removeable cable features the same type of connector on both ends and is reversible. Moreover, this same cable may also be employed to connect a wall transformer unit to recharge the headlamp batteries, thereby eliminating the breakage due to repeated flexing and yanking of the wire that has previously been made a part of a wall transformer supply unit. This being of particular benefit to touring cyclists who will likely be storing the system in their panniers during the daytime.

It is an object of the invention to prevent damage in the case of loose connections as well as to provide for partial operation. In the invention, the alternating output of the generator is rectified with diodes and provided with a voltage limiting device such as a zener diode. The zener need have no effect when the generator output is properly loaded by the headlamp unit, but if the headlamp unit is disconnected, it will limit the inductive spike produced in the generator winding and provide a restrained voltage for the rear warning device of the invention. Hence the system will accept either the incandescent head lamp of the well known generator system or preferably an improved unit containing rechargeable batteries which will provide steady headlamp illumination and power to the rear warning device of the invention, under all conditions of vehicle speed.

It is an object of the invention to disclose a sustantially parallel connected battery and generator system that is not damaged by shorts in the interconnection wiring. A simple electronic fuse circuit utilizing a MOSFET, a transistor, two resistors and a ceramic delaying capacitor is disclosed. This fuse which protects against the damaging flow of battery current in the case of shorted wiring, resets immediately if a generator is providing simultaneous power and upon temporary removal of the load with battery only operation.

It is an object of the invention to use relatively low capacity cells in the optional rechargeable headlamp, which can also be used as a portable lamp, making it smaller, lighter and less expensive. Because the rear warning device of the invention does not require a closely regulated supply potential it is possible to provide regulation for a halogen head lamp bulb within the confines of the headlamp unit only and that such inclusion permits the reduction in the size and electrical capacity of the rechargeable batteries incorporated in the headlamp while enjoying the increased light output available from an incandescent that is always operating at peak efficiency and is not subjected to life-shortening short-term overvoltages. When nickel-cadmium rechargeable batteries are used in the embodiment, the voltage regulating circuitry for the headlamp may have an additional use in automatically shutting off the head lamp when the energy in the batteries has been depleted to a point where further withdrawal might cause damage through potential reversal of one of the individual cells.

The voltage regulator disclosed in the invention has a very minimum voltage and power loss while being composed of only a few inexpensive parts which nonetheless provide without adjustment the initial and long term accuracy of 5% which is required for the proper operation of a halogen bulb. This accuracy and control is provided by an integrated circuit shunt voltage regulator acting in conjunction with a two transistor plus LED power amplifier. The LED which is used in this instance for its electrical similarity with a low voltage zener element makes possible much improved transition characteristics between saturation (fully conducting with low voltage drop) and limiting (linear) operation.

Sony Energytec has very recently announced the development of a new rechargeable lithium-manganese cell which they report to deliver 2.4 times the energy with a weight that is 65% that of an equivalent sized

nickel-cadmium cell. It uses an organic-solvent electrolyte instead of an aqueous solution so that when fully charged there is no further current flow and the battery potential may increase. With the inclusion of the simple low loss voltage regualtor that is disclosed for regulating the potential to the halogen headlamp bulb, such a cell would likely be of great benefit in the practice of the invention if it proves to be a commercially viable product.

It is an object of the invention that overcharging of the batteries can be prevented by a means which causes less current to flow to the headlamp/batteries unit while still allowing for the proper operation of the rear warning lights. In the case of recharging from the generator, the maximum voltage in the system is limited by a zener or a similar element. With the corresponding home wall recharger, all that is necessary is to provide adequate current with an uncritical voltage set by the turns ratio of transformer. In particular if nickel-cadmium cells are used, circuitry may be provided to monitor the current which charges the battery, and a resistive impedance imposed in the charging loop to regulate the flow of this current at times that it would be excessive. However, the self-limiting characteristic of Sony's new lithium-magnesium batteries holds the promise of not needing any such additional circuitry.

It is an object of the invention that when the generator is used to power the rear warning device in a partial operation of the system without the headlamp or batteries being present, that the flash rate of the rear warning device will be at a maximum, and that the omnidirectional warning flashes thus produced will become a partial substitute for the warning that the headlamp would normally provide.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified electrical schematic diagram of the bicycle lighting system of the invention. In this figure the numbers **6–9**, **11–12** given to the sub-circuit blocks refer as well to similarly numbered following figures.

FIG. **2** is an exploded perspective view of the side of the rear warning device along with its combined mounting and electrical connection means. Also shown are a portion of a typical bicycle reflector mounting bracket and part of a connecting wire.

FIG. **3** is an exploded side perspective view of an alternate three-piece case design for use in place of the two-piece case design of FIG. **1** when it is necessary for the retro-reflector to have a color.

FIG. **4** is a front elevational view of the rear warning device of FIG. **1** as it would appear when viewed from a position behind the bicycle upon which it is mounted, showing the portion cut away for FIG. **4**.

FIG. **5** is a cut-away view of the rear warning device showing the LEDs, the window through the retro-reflector for the LEDs, a cross section of the circuit board and the portion of its combined mounting/electrical connection arrangement which is within the device.

FIG. **6** is the detailed schematic of the simple lamp voltage regulator of the invention.

FIG. **7** is the detailed schematic diagram of the lamp voltage regulator circuit of FIG. **6** to which has been added a low battery voltage automatic shutoff feature.

FIG. **8** is the detailed schematic diagram of a current limiting circuit which may be used in conjunction with sealed nickel-cadmium batteries to facilitate their safe recharging.

FIG. **9** is a detailed schematic diagram of an electronic fuse circuit which may be used to prevent damage in the case of abuse or inadvertent shorts in the external wiring.

FIG. **10** is a portion of the detailed schematic of the rear warning device which is shown complete in FIG. **13** which reveals the freerunning oscillator of the invention which is used to drive the MOSFET switch in the charging circuit **30**.

FIG. **11** is a simplified electrical schematic diagram revealing the features of the flashtube trigger circuit **11** of the invention.

FIG. **12** Shows an alternative arrangement which uses semiconductor zener devices to combine the functions of the voltage limiting device **38** and the rectifier bridge **37** that are shown separately in FIG. **1**.

FIG. **13** is the schematic diagram of the rear warning device which is contained on the circuit board shown in perspective in FIG. **2**, cut-away in FIG. **5** and in simplified form in FIGS. **5**, **11–12**.

DETAILED OPERATION OF THE SYSTEM

In the removable headlamp unit **17** incorporating rechargeable batteries of FIG. **1** the headlamp bulb **1** is energized from the battery **3** through the regulating circuit **6** when the user turns on the switch **2**. The lamp voltage regulator **6** imposes a voltage drop represented by the variable resistance **18** to maintain the lamp **1** voltage V_L constant at times when the battery potential V_B exceeds the lamp requirements. An optional low battery auto shutoff circuit **7** can be added to the lamp voltage regulator circuit **6**. This circuit which is especially desireable to use with nickel-cadmium batteries removes the load when the battery voltage drops below a critical level and is almost equivalent in its performance to the opening of switch **2**. The connections **23–24** of the removable headlamp unit **17** provide a path for placing the battery substantially in parallel with the generator so that the battery **3** can supply power to the rear warning lights **13** and power from the generator **14** can reach the battery **3** in order to minimize its discharge or if enough power is being generated, provide for recharging. An electronic fuse circuit shown in block **9** is imposed in this path to prevent the damaging flow of battery current should the external connections place a short circuit between the terminals **23–24**. In the simplified form shown this is represented by a current limiting element **20** and an ideal diode **22** which bypasses it for currents of the opposite direction which source from the generator.

In block **8**, battery overcharging is prevented by decreasing the current flow from the external source in the path provided by connections **23–24** by a varying resistance element **19** which is bypassed by the ideal diode **21** for battery current which flows to the rear warning lights **13**. If rechargeable lithium-manganese batteries are used, it is apparent that the battery overcharge limiting block **8** would not need to be an actual circuit because of charge limiting characteristics inherent in the chemical action involved. With other types of batteries the circuit might be of a form which integrates the current into and out of the batteries **3** or measures some other parameter in order to halt the flow through element **19** altogether when it has been determined that sufficient recharging has taken place. Or it may take a form which is particularly suitable for use with sealed nickel-cadmium batteries that is shown in FIG. **8** to be detailed later which measures the current flowing into

the battery 3 and acts to limit it to a continuously safe maximum value by means of the variable element 19.

When in operation on the bicycle, the external connections to the headlamp unit 17, the rear warning lights 13 and the rectified generator output 12 have common electrical conductor paths which places them in parallel connection one with another. Thus the bicycle frame could be utilized for one of these paths, for instance, by grounding to the frame the positive terminals 26, 28 and either terminal 44 or a contact which would mate directly with terminal 24 thus eliminating the need for any actual wire between these points. When necessary the batteries 3 can be recharged from the bicycle generator with the headlamp switch 2 in the off position or more conveniently by removing, and then connecting the headlamp unit 17 to the output of a wall recharger unit 16. These arrangements are shown in FIG. 1 by the cable 15 which through conductors 39–40 connects headlamp terminations 23–24 to bicycle mounted terminations 43–44 or with the cable 15 in an alternate position shown in dashed lines the headlamp terminations 23–24 are connected through conductors 39'–40' to the wall recharger terminals 41–42.

The bicycle generator 14 typically has a small drum in contact with the tread of one of the tires in order to rotate the magnet 35 at a high rate. This induces a voltage in the magnetically linked coil 36 which is connected to the input of a bridge rectifier 37, the output of which feeds the terminals 25–26. A voltage limiting device, represented as zener 38, is also connected to the rectified output 25–26 of the generator. The limiting voltage value of element 38 is chosen to be above the maximum voltage into the rechargeable batteries unit 17 including expected losses in the wiring except when the battery charge limiting block 8 is active. Hence all the power output of the generator will go towards lighting the lamp 1, lighting the rear warning lights 13 and recharging the batteries 3 until excess current is available from the generator at which time it will be shunted through the element 38 because of the action of the battery overcharge limiting 8 that is employed. The voltage limiting element 38 is also sized to accept the full power output of the generator 14 in the case of the headlamp unit 17 being disconnected. This in addition to the electronic fuse 9, assures that the system is protected against damage due to breaks or shorts in the common path wiring on the bicycle itself which places the various units in parallel combination which in FIG. 1 is seen to be the connections between terminals 24, 26 and 28; and the connections between terminals 23, 25 and 27 where one of these two as noted previously could be the bicycle frame itself. It is further noted here that the internal inductance of the coil 36 protects the generator 14 in case of shorts as it did in the generator only system of the prior art.

The rear warning lights which are powered through combined mounting and electrical terminals 27–28 comprise a gas filled discharge tube 5 in conjunction with a high voltage storage capacitor 29 to produce dispersed flashes of light and an LED 4 which may actually be a series parallel combination of a plurality of LEDs 4*a*, 4*b* to produce a beam of monochromatic light which is typically a long wavelength red that is highly recognizable as a rear vehicle lamp. The pulsed gas discharge light source formed of high voltage capacitor 29 and flash tube 5 is energized by a charging circuit 30 whose input is connected to the supply potential on terminals 27–28 through the LED 4. The charging circuit 30 shown is a voltage conversion flyback type consisting of an input filter capacitor 33, a storage inductor 31 with a voltage step-up winding, a switch 32 for allowing the periodic build-up of current in the inductor 31, an oscillator shown in block 10 for periodically opening and closing the switch 32, and a rectifier 34 for releasing the energy stored in the inductor 31 to the storage capacitor 29. Additionally in the rear warning lights 13, a trigger circuit shown in block 11 is needed to initiate the pulse discharge into the tube 5 in response to the potential on capacitor 29, which is being incrementally increased by the charging circuit 30, having attained to a sufficient amount.

The high frequency rectangular wave oscillator 10 includes means of adjusting the time proportions of its waveshape so that the ON time and duty cycle of switch 30 are changed in response to the supply potential at terminals 27–28 with the effect that the current I_C into the rear warning light circuit is maintained substantially constant. The current I_C also flows through the LED 4 so that the effect of the oscillator adjusting means is to make the current energizing the LED substantially constant which allows for proper operation of the rear warning lights in spite of a changing supply voltage V_S on terminals 27–28 caused by rectified pulsations and varying amplitude due to varying bicycle speed from generator 14 as well as the charge/discharge cycle of the batteries 3.

Consider the following example based on the use of a 5 cell nickel-cadmium battery pack and a 6 volt 3 watt nominal rating bicycle generator. Headlamp bulb 1 is chosen to be 6 volts at 2.4 watts which is a standard item and the lamp voltage regulating circuit 6 has a minimum voltage loss of 0.15 volts making the minimum battery voltage V_B just before loss of regulation equal to 6.15 volts. This is quite satisfactory since the midpoint discharge potential of the nickel-cadmium batteries will typically be 6.25 volts. A standard value 8.7 volts 5 watts rated zener is chosen for the limiting element 38 which places it above the crest value equal to 8.48 volts of a 6 volt sinusoidal wave. If the switch 2 is off for charging, the battery voltage V_B could increase to as much as 7.5 volts and consequently a loss of 1.7 volts in wiring and normal passage through the protective blocks 8 and 9 is allowed before voltage limiting element 38 will conduct, a condition that is easily met by the circuits disclosed in FIGS. 8, 9 to be detailed later. The rear warning lamps are designed so that the current I_c is similar to prior art generator tail lamps or 0.1 ampere for the range of voltages encountered in operation. The minimum operating voltage is encountered in battery only operation when for conditions approaching exhaustion about 1 volt per cell or 5 volts total is available while the maximum voltage encountered is the peak limited by the element 38 which allowing for practical devices and tolerances might be about 9.5 volts.

Continuing with the example, the generator 14 has an output frequency proportional to bicycle speed, ranging in the construction of those presently manufactured from 100 to 230 Hz for a bicycle speed of 12 mph. The converter in the charging circuit of the rear warning lights 14 is made to operate at a much higher frequency in order to reduce the size of the required inductor 31 and the input filtering capacitor 33 which is effective at the charging circuit 30 converter frequency 10 but not at the generator 14 frequency. This choice of a higher converter frequency also minimizes the stress on the LED 4 which typically have a thermal time constant

which is on the order of the period of the generator **14** frequency. With the oscillator of FIG. **10**, to be explained in detail later, the frequency decreases and the duty cycle increases in response to a decrease in the supply voltage V_s at terminals **27–28**, thus maintaining the converter current I_c averaged by filter capacitor **33** which also lights the LED **4** substantially constant. At the nominal V_s equal to 6.25 volts the current draw I_c is 100 milliamperes with an operating frequency of 25 KHz and a duty cycle of 61%; with V_s lowered to 5 volts the current draw I_c is 103 milliamperes, the frequency lowers to 18 KHz and the duty cycle increases to 73%; and with V_s raised to 9.5 volts the current draw I_c is 82 milliamperes, the frequency increases to 36 KHz and the duty cycle decreases to 46%.

The AC mains recharger **16** contains a step-down transformer **45** encased in a plastic insulating structure of essentially cubic shape. Short prongs **46** connected to the transformer primary protrude from the case for insertion in a standard wall outlet while the lower voltage secondary is rectified by diodes **47**, filtered by capacitor **48** and made available for interconnection with the headlamp unit **17** by the terminals **41–42**. Although most such wall transformer units in use today have permanently attached cables for their interconnections in place of the terminals **41–42** that are shown, it would be a real advantage to the cyclist to be able to separate the cable thereby avoiding fatigue breakage problems of the cable and to facilitate the packing of the transformer unit into panniers on the bicycle.

Moreover in a version of the system which does not rely upon the bicycle frame for a common interconnection, the same cable **15** can be used in a dual role either for recharging away from the bicycle or to span the front to back distance of the bicycle in connecting the headlamp unit **17** to the terminal connectors **43–44** which would for this version of the system be contained with the rectifiers and voltage limiter **10** as a part of generator **14** or if a prior art generator were to be used, in separate enclosure near the generator. Furthermore an additional set of terminals connected in parallel and of similar construction to the terminals **43, 44** would be provided in place of the terminals **25, 26** so that a cable with one end similar to the ends of cable **15** and with ring lugs **77** could be connected to the rear warning device terminals **27, 28**. These arrangements are more suitable to the casual cyclist since the system is connected with cables having either plug-in connectors or the easily removed thumbscrews **74**. And if all the connectors are similar, the cable from the rear warning device can connect directly to headlamp **17** or to the generator-rectifier unit as an intermediary depending upon the bicylist's requirements.

DETAILED DESCRIPTION OF THE REAR WARNING DEVICE

Referring to FIG. **2**, the preferred embodiment is assembled from two transparent plastic molded pieces **60** and **61** which are glued together at their edges **63** to enclose a printed circuit board **62** and components. The retroreflector which faces in the same general direction as the LEDs **4** is formed by a molded pattern **64** of cube corners on the inside surface of plastic piece **61** which can be partially seen in FIG. **5**. The LEDs **4** shine through a window area **65** which is a separate portion devoid of retroreflective cube-corners of the central face area of the plastic case piece **61**. This piece is further seen to have two side surfaces **66, 67** which are at an inclination of approximately 30° with the central section. This construction is presently employed to meet current CPSC regulations which have been adopted to ensure adequate performance when there is considerable angular displacement between the direction of the bicycle and the direction of an approaching vehicle. Although the CPSC performance specifications only require a minimum amount of returned light, some researchers think that a minimum area also should be specified. At the present time the central section of the typical bicycle reflector has an effective area of about two square inches and each of the side sections have about one square inch.

Although one of the side sections **66, 67** obviously must disappear for horizontal viewing angles exceeding 30° nonetheless, the orientation angles chosen for the cube corners **64** on the inside surfaces of **61** are different for the two halves of the "split field" central section and the two side surfaces which are seen in the cross-section of FIG. **5**. Typically the side sections which are retroreflective for at least an additional 10° to either side are effective in outlining the entire face of **61** to the driver of an approaching vehicle.

The gas filled flash tube **5** is disposed horizontally below the high voltage storage capacitor **29** near the bottom edge of the plastic case formed by reflector **61** and rear piece **60**. The usual plastic sleeve which insulates and carries the markings for capacitor **29** is removed to allow its shiny aluminum case to act as a reflector for the upwards directed portion of the flashes that are emitted from the flash tube **5**. The high intensity flashes of white (colorless) light must pass through at least one of the enclosure pieces **61, 60** to be visible. These plastic pieces could be tinted red or amber, such as the lens of an automobile tail light. However, doing so will dramatically lower the visibility because by filtering two of the primary colors (green and blue), only a third portion of the emitted spectrum would remain, and the sensitivity of the human eye is less for red and amber than it is for green. An additional problem is that the high intensity of the light may saturate the tinting substance, and, consequently, the flash will have only a partially colored appearance. The best choice then is a clear material for the pieces **60, 61**.

If it is necessary to have a tinted reflector because of legal restrictions for instance that require the reflector surface to have a red appearance, then an alternate three-piece case construction shown in FIG. **3** could be used. In this instance the separate case piece **68** which encloses the flashtube **5** could be molded of clear plastic while the retro-reflector piece **69** could be tinted red and the backing piece **70** could be opaque as is customary for reflectors of present manufacture.

It is expected that the unit will be mounted on the bicycle in the places where the red rear reflectors are presently being utilized. On a bicycle with a rear utility rack, this would be on a protrusion at the rear extremity of the rack. For bicycles not so equipped, the reflector is usually under the seat fixed to a bracket **72** which has been attached to the bicycle seat stay crosspiece (not shown) along with the rear caliper brake. The bracket **72**, usually formed from thick sheet steel, typically has two ¼" holes **73** spaced on ¾" centers as illustrated FIG. **2**. The typical reflector that mates with it has a ¼"×20 threaded steel stud projecting through the rear at the center with a short ¼ round molded boss located for the second hole. Usually the top and bottom of the reflector are interchangeable and thus the stud can be placed in

either hole. The comparatively large diameter stud provides for sufficient tightening to prevent loosening from vibration while the molded boss prevents rotation.

The preferred embodiment of the rear warning device **17** is held securely in place on the mounting bracket **72** by two thumbscrews **74** which mate with the internally threaded brass standoff spacers **27, 28** which are staked onto the top side of printed circuit board **62** and soldered to the foil traces on the opposite side. The thumbscrews **74** are insulated from the bracket **72** where they pass through the holes **73** by hollow insulating bosses **75** molded onto the exposed side of the rear plastic enclosure piece **60** as seen in FIG. **5**. If electrical contact with the mounting bracket **72** is desired then a metal pressure washer **76** is used under the head of the thumbscrew **74**. Otherwise, a spade lug **77** attached to a wire lead and an insulating fiber pressure washer **78** are used under the thumbscrew **72** as seen on the upper thumbscrew of FIG. **1**. Hollow supporting bosses **77** concentric with the outside bosses **75** are molded to the inside surface of rear enclosure piece **60** and make physical contact **80** with the smooth swaged end of threaded spacers **27, 28**. When the thumbscrews **74** are tightened, pressure on the engaged threads and against the smooth ends of the spacers **80** acts to exclude dirt and water from the interior of the warning device **17**.

The circuit board **62** has three cut-out areas as is shown in FIGS. **1, 5**. One area is for the high voltage storage capacitor **29** and agas filled flash tube **5**. Another is for the high frequency converter transformer **31** which allows its ferrite core to be glued to the top surface of the board, and the third is for the trigger coil **81**. These components are the largest and have been located behind the central section of the reflector **1** so as to minimize the thickness of the assembled unit thereby retaining the strength and durability that is characteristic of the modern design bicycle retroreflector. The leads from all the components (with the exception of the transformer **31** and the trigger wire from coil **81** which may be connected directly to flashtube (**5**) extend through holes from the plain front surface of board **62** to the rear foil side where they are soldered as is the customary practice for single-sided circuit board construction.

DETAILED ELECTRICAL OPERATION OF THE HEADLAMP UNIT

The simple lamp voltage regulator of block **6** in FIG. **1** is shown in detail in FIG. **6**. Battery potential V_B is applied to the lamp **1** through the PNP pass transistor **85** when the headlamp switch **2** is closed. Base current for the pass transistor **85** comes from the negative battery potential through limiting resistor **86** and NPN driver transistor **87**. An LED **88** is connected from the output of the voltage regulator, which is the collector of the pass transistor **85**, to the emitter of the driver transistor **87** thereby creating negative voltage feedback. The LED **88** is a low current type utilized for its non-linear V-I characteristics which are more suitable than that of low voltage zeners which could be substituted. The LED **88** will be lighted whenever the regulator is in a linear operation with the battery voltage V_B sufficiently greater than the regulated lamp potential V_L and will extinguish when the driver transistor **87** allows the maximum base current to flow to pass transistor **85** causing it to saturate. The base of driver transistor **87** which is directly related to the output voltage V_L by the difference of the voltage drop of LED **88** as

compared to the base-emitter drop of transistor **87** is precisely controlled by shunt regulating device **89**. Resistors **90, 91** form a voltage divider on the output voltage V_L to apply a potential **92** to the adjusting terminal of the shunt regulating device **89**. A pull-up resistor **93** provides current to the driver transistor **87** base and to the anode of the shunt device **89** for it's proper operation. The shunt regulating device **89** then maintains the lamp voltage V_L so far as the available battery potential V_B and the saturation limit of pass transitor **85** will permit. The integrated shunt regulating device **89** contains frequency stabilizing components sufficient for its own operation and because the current amplification of discrete transistors **85, 87** is stabilized by a separate voltage feedback path created by LED **88** no additional frequency compensation is needed.

The integrated circuit shunt regulator **89** can be a type TL431C which is quite inexpensive and is factory trimmed to a tolerance of two percent. If one percent resistors are used for the divider **90, 91** then the overall accuracy as assembled will be four percent which adequately meets the requirements for the use of the halogen bulb **1**. Continuing the example of **5** nickel-cadmium cells for battery **3** and a 6 volt 2.4 watt bulb **1** then the other parts used could be a TIP **32** for pass transistor **85**, a PN2222 for driver transistor **87**, 150 ohms for driver source resistor **86**, 1.0K ohms for pull-up resistor **93**, 14.3K ohms 1% for divider resistor **91** and 10.0K ohms 1% for divider resistor **92**.

In FIG. **7** the automatic cutoff circuit of block **7** in FIG. **1** has been added to lamp voltage regulator circuit block **6** of FIG. **6**. With nickelcadmium and possibly other types where a number of cells have been placed in series, it is desirable to terminate the discharge when the total battery potential drops to a value which is indicative of one of the individual cells becoming completely discharged. Because the pass transistor **85** is in saturation when the battery voltage V_B nears the cutoff value, the lamp voltage V_L can be monitored instead by divider resistors **95, 96** whose output **99** is applied to the adjusting terminal of a shunt voltage switch **100** which then allows drive current to flow to the pass transistor **85** through limiting resistors **86*a*, 86*b*** only as long as the battery voltage is higher than the cutoff value. Once the circuit **7** passes the cutoff point there will be anode voltage present on the shunt regulators **89, 100** but because no voltage is applied to their adjusting terminals only very small leakage currents will flow.

The large value capacitor **101**, which becomes charged only after the circuit **7** has passed into cutoff, is added to delay the cutoff so that the lamp voltage V_L can be established when the head lamp switch **2** is first turned on. Optionally a large valued resistor (not shown) for aiding in the resetting of the circuit can be added in parallel with the LED **88** to discharge the capacitor **101** which otherwise is discharged very slow by the leakage currents of the semiconductor devices. The resistor **86** of FIG. **6** which limits the pass transistor **85** base drive current is now split into two resistors **86*a*, 86*b*** to provide a tap point so that there is no reverse voltage impressed on capacitor **101** enabling an electrolytic to be be used.

Continuing the example, the shunt voltage switch **100** is the same type TL431C integrated circuit shunt voltage regulator that was used previously as a voltage regulating element, the driver source resistor **86*a*** is 56 ohms, the source resistor **86*b*** is 27 ohms, the voltage divider resistors **90, 91** can both be 33K ohms 5%, the

capacitor **101** can be a 47 μF aluminum electrolytic and the optional bleeder resistor can be 470K ohms.

The circuit of FIG. **8** represents one of the possible ways in which the battery overcharge protection block **8** of FIG. **1** can be accomplished. Sealed nickel-cadmium cells have the property of being able to accept a continuous current in overcharge if that current is limited to a safe amount related to their capacity, this usually being 10% of the current rating for a one hour discharge. The circuit of FIG. **8** operates to monitor the current which enters and leaves the battery which has been divided into two parts *3a*, *3b* by way of the low valued shunt resistor **105**. The voltage across this shunt resistor which is proportional to battery current flow is then time averaged by resistor **106** and capacitor **107** with an added offset introduced by resistor **108** equivalent to the C÷10 current, which the battery is able to tolerate in continuous overcharge, and then applied to the differential inputs of the operational transconductance amplifier **109**. The output of the amplifier **109** which is a current source with what appears electrically to be a very high impedance is applied to the gate terminal of MOSFET **110** which is shunted by capacitor **111**. The phasing of the differential inputs of the transconductance amplifier **109** is such that if there is no net average charge current flowing into the battery, the potential of the MOSFET **110** gate will be nearly that of the positive terminal of battery *3a* making its channel resistance low and allowing unlimited current flow into or out of the terminal **23** which connects to the battery *3b*negative. For charging conditions that would be otherwise excessive, the amplifier **109** acts to lower the gate potential of MOSFET **110** to regulate the average current which charges the battery *3a*, *3b* to that value which can be continuously tolerated.

The capacitor **111** acts to smooth the gate-source potential of MOSFET **110** so pulsations in the external voltage V_x do not rapidly affect its conductance. The substrate connection to the integrated circuit amplifier **109** must be returned to the most negative point of the circuit which is terminal **23** during charging conditions due to the externally applied potential V_x. Although both capacitors **107**, **111** are effective in filtering the current signal from the battery shunt **105** which contains a sizeable ripple due to the charging sources **14**, **16** being alternating voltages of relatively low frequency, stability of the feedback loop does not pose a problem. Because there is no significant amount of current required to drive the insulating gate of the MOSFET **110** the resistor **113** which fixes the quiescent current consumption of the transconductance amplifier **109** is made quite large so that there is no difficulty encountered in powering the circuit of FIG. **8** continuously from the rechargeable batteries *3a*, *3b*.

The MOSFET device **110** contains a substrate diode inherent in its manufacturing process that functions in a practical way as the ideal diode **21** which is shown in FIG. **1**. Thus the maximum voltage difference under discharging conditions between the battery voltage V_s and the external voltage V_x would be limited to voltage drop of this semiconductor substrate diode were it not for the fact that under discharging conditions the MOSFET **110** channel resistance will likely make this voltage much less considering that the MOSFET **110** is required to pass the current which lights the head lamp **1** which is sourced by the generator **14** and that this is much larger than the battery current which flows to light the rear warning lights **13**.

Using A size cells rated at 500 milliampere-hours in the continuing example, the operational transconductance amplifier **109** is an integrated circuit type CA 3080E, the shunt resistor **105** is 0.33 ohms, the filter resistor **106** is 68K ohms, the filter capacitor **107** is 0.22 μF, the offsetting resistor **108** is 9.1 megohms, the MOSFET **110** is a type IRF 523, the gate filter capacitor **111** is 0.01 μF, and the bias setting resistor **113** is 1.5 megohms.

FIG. **9** details a resettable electronic fuse circuit which can be utilized for the protection block **9** of FIG. **1**. Current is normally allowed to flow freely in the channel of MOSFET **115** because its gate is biased by the battery voltage V_s through the pull-up resistor **116**. If however if the battery discharge current becomes great enough to create a voltage drop in the channel resistance of MOSFET **115** which causes base current to flow through resistor **117** into the base of transistor **118**, the transistor will conduct thereby removing the gate drive to the MOSFET **115** causing it to shutoff. As long as there is a discharging load connected externally between terminals **23-24** the circuit will remain in a shutoff state but if this is unplugged then the circuit will return to a conducting state. Externally applied voltage V_x which sources current in the opposite direction to charge the batteries will reverse the voltage drop across the channel of MOSFET **115** and can also allow the circuit to return to the normally conducting state.

The capacitor **119** is added to slow down the response to allow loads which in normal operation may have a short term high current requirement such as the initial connection of a capacitance or an incandescent bulb while preventing high magnitude currents which flow for a time sufficient to burn the insulation on the wiring or are otherwise harmful. The MOSFET device **115** contains a substrate diode inherent in its manufacturing process that functions in a practical way as the ideal diode **22** which is shown in FIG. **1** to carry the current from the generator **14** to the battery in a charging direction. Whether the substrate diode actually carrys charging currents depends on whether the fuse circuit has been shutoff and on the channel resistance of MOSFET **115**.

Continuing the example; the MOSFET **115** may be a type IRF 153 which has a channel resistance of about 0.4 ohm giving a shutoff current in the range of 0.5-1 ampere, the pull-up resistor **116** could be 15K ohms, the base resistor **117** could be 47K ohms, the NPN transistor **118** a type 2N5089 and the delay capacitor an 0.1 μF ceramic.

In FIG. **1** the bridge rectifier **37** and the voltage limiting element **38** are shown as separate elements in the rectification portion **10** connected to the generator winding **36**. However because semiconductor zener diodes may be also be used as rectifiers in the forward direction, it is possible to use an alternate arrangement shown in FIG. **10**. In this arrangement the anodes of the zener diodes are grounded to the frame to facilitate the heat sinking that is required on these components which must accept nearly the full output of the generator **14** when the headlamp unit **17** is not connected.

DETAILED ELECTRICAL OPERATION OF THE REAR WARNING LIGHTS

FIG. **11** shows the workings of the oscillator block **11** of FIG. **1**. The comparator **125***a* is a high gain amplifying device whose output terminal is high or low depending on which of the two signals respectively ap-

plied to its positive and negative inputs is the largest. A voltage reference V_R is developed by passing a bias current through a low current LED **126** and is applied to the positive input of the comparator **125**a in full when the comparator output is high. The comparator output which is connected to the gate of the MOSFET switch **32** will more conveniently be referred to as the oscillator output **127**. The negative input of the comparator **125**a is connected to capacitor **128** which will be charged by current flowing through resistors **129, 130** until its potential equals V_R which is the potential on the positive input terminal of comparator **125**a, which will cause the oscillator output **127** to reverse and become low. The voltage on the positive input of the comparator will now be reduced by the voltage divider action of resistors **131, 132** which have been connected to the lower supply potential by diode **133**. The timing capacitor **128** will now begin discharging through resistor **130** whose applied potential has been removed by the conductance of diode **134** until the comparator inputs are again equal which changes the oscillator output **127** back to a high state and causes the cycle to repeat.

During the discharge time period of timing capacitor **128** the positive comparator input and the discharging current through resistor **130** will be unaffected by supply voltage changes in the circuit because the reference voltage VR remains constant and because of the relatively equal clamping action of diodes **133, 134**. Thus the corresponding MOSFET switch **32** OFF time will be constant. During the charge time period of the timing capacitor **128** the voltage impressed upon the series combination of timing resistors **129, 130** will be approximately equal to the charging circuit input voltage V_c. This is because the voltage drop across the light source LED **4**b is similar to the reference voltage V_R even though different devices are used and each are subjected to different currents and because the voltage change on the timing capacitor **128** caused by the oscillations is not large, roughly one third of the amount of the reference voltage V_R assuming divider resistors **131, 132** are equal. Thus the corresponding MOSFET switch **32** ON time will be an approximate inverse relationship with charging circuit input voltage V_C and the duty cycle will decrease as the ON time shortens. The average charging circuit input current I_C depends upon the ON time of the switch **32** and its duty cycle, thus the inverse relationship of the oscillator ON time just described is effective in maintaining the average current I_C constant.

Typical parts which may be used which give the duty cycle and frequency performance factors given previously are: type number 1N4148 for the clamping diodes **133–134**, 10K ohms for the two resistors **131–132**, 22K ohms for OFF timing resistor **130**, 91K ohms for ON timing resistor **129** and 1000 pF for the timing capacitor **128**.

The workings of the flashtube trigger circuit **12** of FIG. **1** are detailed in FIG. **12**. The potential on high voltage storage capacitor **29** increases with time due to charging circuit **30** (not shown in FIG. **12**) until the trigger capacitor **138** is discharged by SCR **139** into the primary of trigger coil **81** which subsequently fires the gas filled flash tube **5**. The trigger capacitor **138** is charged from the upper tap of a voltage divider composed of resistors **140–142** which is supplied with the potential on storage capacitor **29**. The potential on the lower tap of the voltage divider is compared with a reference voltage V_R by the comparator **125**b and if they are equal the comparator allows the current I_G to flow into the gate of the SCR causing it to trigger.

The total resistance of the divider **140–142** can be made large to provide minimum power loss from capacitor **29** only if the leakage current through the SCR **139** which affects the voltage divider can be minimized and if false triggering from noise generated in the resistors and from stray capacity coupling to other points in the circuit, can be suppressed. The regenerative leakage current through SCR **139** is minimized by the comparator **125**b output which typically holds the gate-cathode voltage of SCR **32** to less than 0.1 volts, and the noise current at the lower divider tap **141–142** is shunted to ground by the feedback capacitor **143** to eliminate false triggering. As the circuit nears the trigger point, the gate-cathode voltage of SCR **139** will increase, however before this voltage can increase to the range of 0.3 or more volts which causes an increase in the regenerative leakage currents, the capacitor **143** introduces positive feedback into the lower tap point of the voltage divider **141–142** forcing the unconditional triggering of SCR **139**.

The arrangement of trigger coil **81**, trigger capacitor **138**, SCR **139** and divider resistors **140, 141** is somewhat different than FIG. **13** shows, however this is known to be an unimportant change. The two determining factors are that the SCR, the trigger capacitor and the primary of the trigger coil be in a series loop and that the trigger capacitor be charged by the voltage divider tap point between resistors **140–141**.

In a an example application of this circuit which provides a flash trigger pulse when the potential of storage capacitor **29** reaches 320 volts, it is convenient to use a type 2N5064 which is packaged in the small TO-92 plastic package for the SCR **139**, a film and foil type 0.022 μF trigger capacitor **138** and trigger coil **81** which are rated and operated at only 200 volts through the dividing action of resistor **140** of 3.0 megohms and resistor **141** of 5.1 megohms. The feedback capacitor **143** can be a ceramic type in the range of 1-10 nF and the lower dividing resistor will be approximately 50k ohms.

The complete schematic for the rear warning lights **13** is shown in FIG. **13**. An LED part number ESBR5603 manufactured by Stanley Electric Co. of Japan, which emits a deep red, **660** nm wavelength, beam with a total dispersion angle of about 22° can be used for the LEDs **4**a, **4**b which are shown in a series-parallel combination in FIG. **13**. These devices have a current rating of 50 milliamperes so that a minimum of two parallel units would be required for the 100 milliamperes current I_C of the example given previously. Four paralleled devices as shown here includes derating the devices to allow for possibly uneven current distribution and because it may be desireable to allot slightly more power to the rear warning lights than was done in the prior art. The voltage drop of the Stanley devices is about 1.75 volts hence the voltage V_C at the input to the charging circuit which appears across capacitor **33** is about 1.5 volts when, from the continuing example, a nearly exhausted nickel-cadium battery supplies 5 volts at terminals **27–28** but is 6 volts when the generator as limited by the zener **38** is supplying the maximum of 9.5 volts.

The capacitor **33** at the input of the charging circuit must handle a high ripple current at the conversion frequency and have low impedance to minimize power lost. These requirements are best met with a tantalum

electrolytic instead of the cheaper aluminum. Tantalums also provide the benefit of smaller size and longer service life. At a conversion frequency in the range of 18–35 KHz as detailed in the example of the oscillator **11**, a 6 volts -47 μF unit is adequate and not overly expensive. The inductor **31** consists of 240 turns total with 30 turns for the primary and is assembled on a 12 mm ferrite EE shaped core that has a small air gap. The MOSFET switch **32** is preferably a "logic level drive" type so that the V_S supply minimum of 5 volts can saturate it. A type number 2SK739 which has a breakdown rating of 60 volts and an ON resistance of about 0.25 ohm is quite satisfactory here.

The energy delivered per flash by the storage capacitor **29** to the flash tube **8** is proportional to the difference in the squares of the initial voltage and the remaining voltage, a characteristic of the flash tube, here about 60 volts. It is a fact that the size of an aluminum electrolytic capacitor decreases with an increase in voltage rating given the condition of equal energy storage. The preferred embodiment thus uses a higher voltage, 10 μF at 350 VW unit which nonetheless results in capacitor **25** still being the largest component inside the somewhat limited space formed by plastic enclosure pieces **60**, **61**. This necessitates the use of a flash tube with a higher rating and results in less efficiency in the charging circuit **30** due to the higher voltage step-up required although the measured performance of better than 70% is thought to be adequate.

The high voltage diode **34** must be a fast recovery type such as the 1N4936 or alternatively it can consist of three lower voltage 1N914 computer diodes in series. The latter combination gives better efficiency because the computer diodes turn-off faster and have lower capacity which results in less power being lost in the coil ringing, but there is some risk in the combination of unmatched parts which are not normally used in this type of application.

An integrated circuit dual comparator of type number LM 393 is used for the comparators **125***a*, **125***b* because it is inexpensive and because it has several features which are particularly desireable. This device has an open collector output which can be taken more positive than its power supply terminal and it can be powered with as little as 3 volts. This enables the full supply voltage V_S to be applied to the gate terminal of MOSFET **32** through pull-up resistor **146** with a typical value of 10K ohms while the dual comparator's power supply terminal **147** is protected from the application of reverse voltages by the LEDs **4***a*. The supply terminals of the integrated circuit comparator **125** are bypassed by capacitor **148** which may be a 0.1 μF or larger ceramic. The bias current I_S to the LED **126** to create the reference voltage V_R is provided by resistor **149** of 1K ohms and the gate current I_G for SCR **139** is supplied by resistor **150** of 4.7ohms.

The embodiment of the invention which is thought to be the most useful has been presented along with device types, part values, performance levels and constructional details to facilitate understanding, but this should not be considered restrictive. Although the invention has been described, in detail for use on a bicycle, the system of the invention with its uncomplicated hook-up and modest power requirements could be used on other small vehicles, especially those lacking a sizeable engine. And the high visibility, ease of attachment, light weight and low power drain of the steady-flashing-reflector warning device may be especially useful for pedestrians and joggers.

I claim:

1. A combination electric warning light and retro-reflector for small vehicle or pedestrian comprising
- a retro-reflector including a transparent body having a multiplicity of corner reflectors molded on a substantially flat face thereof lying substantially in a plane adapted to be oriented approximately vertically and having an effective area of at least one square inch,
- a directional beam emitting monochromatic light source juxtaposed with said retro-reflector in a manner which leaves said beam unobstructed by said retro-reflector, said source being oriented to cause said beam to have a direction generally normal to said plane.
- a pulsed gas discharge light source arranged to emit light through the plane of said retro-reflector with a wide angle of dispersion, and
- means located at least partially behind the outline of said retro-reflector for supplying power to said monochromatic light source and gas discharge light source.

2. Apparatus as recited in claim **1** wherein said monochromatic light source comprises a plurality of light-emitting diodes.

3. Apparatus as recited in claim **1** wherein said pulsed gas discharge light source includes a gas-filled flash tube, a capacitor, and a charging circuit therefor.

4. Apparatus as recited in claim **1** wherein said gas discharge light source is arranged to emit light through said face of said corner reflectors.

5. Apparatus as recited in claim **3** wherein said means for supplying power is connected to provide current serially through said monochromatic light source and said charging circuit.

6. Apparatus as recited in claim **1** wherein said monochromatic light source includes a plurality of light-emitting diodes lying proximate to the plane of said retro-reflector and within the outline of the effective area of said retro-reflector.

7. A regulation circuit for a combined LED and pulsed gas discharge lamp warning light comprising;
- at least on LED,
- a pulsed gas discharge light source including a charging circuit, said charging circuit being connected to receive the current flowing through said LED,
- means operable for regulating the power supplied to said LED and charging circuit from a substantially unipolar potential source of possibly great electric potential variation and of undetermined internal impedance, and
- means for maintaining a current through said charging circuit at a relatively constant average value with the result that the current and power supplied to said LED is substantially constant, said means for maintaining the current in said charging circuit at relatively constant average value includes a switch and means for sensing the voltage across said charging circuit causing the on-time of said switch and the charging circuit duty factor to increase in response to decreases in said voltage.

8. Apparatus as recited in claim **7** wherein said at least one LED comprises a plurality of LED's at least four in number arranged in a series-parallel circuit.

9. Apparatus as recited in claim **7** wherein said means for causing the on-time of said switch to increase in-

cludes a voltage reference element, a capacitor-resistor circuit charged by said voltage, and a comparator element.

10. A headlamp and warning light system for a bicycle or the like comprising;

a generator,

a secondary battery connected substantially parallel with said generator,

a warning light including an LED light source having a relatively low power requirement,

a headlamp having a relatively high power requirement,

means for providing adequate voltage and current from said battery to said warning light when said headlamp is operative and said battery is not fully charged, and

means for preventing excess voltage or current being supplied to said warning light from said generator other than when said battery is not fully charged and said headlamp is operative,

said warning light, said headlamp and said battery have a common electrical path for which the conductive frame of said bicycle may be utilized.

11. Apparatus as recited in claim **10** wherein said generator has an integral rectifying circuit including voltage limiting elements tending to regulate the voltage produced by said generator.

12. Apparatus as recited in claim **10** further including an undervoltage disconnect circuit for placing said battery in a non-discharging mode rather than a discharging mode.

13. Apparatus as recited in claim **10** further including means for limiting recharging current to said battery.

14. Apparatus as recited in claim **10** further including means for preventing battery overdischarge by limiting current through one of the electrical paths that connects to the headlamp.

15. A combination electric warning light and retroreflector for small vehicle or pedestrian comprising

a retro-reflector lying substantially in a plane adapted to be oriented approximately vertically and having an effective area of at least one square inch,

a directional beam emitting monochromatic light source juxtaposed with said retro-reflector in a manner which leaves said beam unobstructed by said retro-reflector,

a pulsed gas discharge light source arranged to emit light through the plane of said retro-reflector with a wide angle of dispersion,

a circuit board disposed generally parallel to said plane,

parts for the operation of said monochromatic light source and said gas discharge light source being affixed to and connected by the circuit board,

the circuit board together with said parts being proximate to said retro-reflector, and

means for connecting an electrical potential, external of said warning light, to the circuit board to energize the light source means through the circuit established by said parts and circuit board,

said gas discharge light source including a first electrical element consisting of a gas-filled flashtube for producing warning flashes and said monochromatic light source including a second electrical element comprising at least one LED for producing a steady light,

said directional beam being produced steadily,

said warning flashes being broadly dispersed to the environment,

the second electrical element being in electrical series combination with the input of a voltage step-up converter, said combination being connected to said external potential by said connecting means, the output of the voltage converter charging a storage capacitor which is repeatedly discharged by firing the flashtube.

16. Apparatus as recited in claim **15** wherein said monochromatic light source comprises a plurality of light-emitting diodes.

17. Apparatus as recited in claim **15** wherein said retro-reflector includes a transparent plastic body having a multiplicity of corner reflectors molded on a substantially flat face thereof.

18. A combination electric warning light and retroreflector for small vehicle or pedestrian comprising;

a beam emitting light source,

a gas discharge light source,

an electrical power supply and control circuit,

means for connecting an electrical potential, external of said warning light, to said circuit,

said gas discharge light source comprising a first electrical element including a gas-filled flashtube for producing warning flashes and said beam-emitting light source including a second electrical element comprising at least one LED for producing a steady light,

said second electrical element being in electrical series combination with the input of a voltage step-up converter, said combination being connected to said external potential by said means for connecting an electrical potential, the output of said voltage converter charging a storage capacitor which is repeatedly discharged by firing of said flashtube,

said beam emitting light source comprises a plurality of light-emitting diodes.

19. In a warning light, a trigger circuit responsive to the potential applied to a pulsed gas discharge lamp arranged to emit light generally through the plane of a retro-reflective surface comprising;

a silicon controlled rectifier having a gate,

a trigger capacitor,

means to charge said trigger capacitor from the potential at terminals of said gas discharge lamp,

an integrated circuit comparator having a non-inverting input and effectively shorting the gate junction of said silicon controlled rectifier to substantially reduce the anode leakage current,

a voltage divider connected thereto, and to receive the potential on said pulsed gas discharge lamp, and

a positive feedback capacitor connected between said non-inverting input and said gate of the silicon controlled rectifier whereby consistent triggering is achieved,

said means to charge said trigger capacitor includes a resistor connected between an electrode of said pulsed gas discharge lamp and said trigger capacitor.

20. The trigger circuit of claim **19** wherein said voltage divider comprises two resistors, the first of which is connected between a terminal of said trigger capacitor and said non-inverting input and the second of which is connected to pass current from said non-inverting input back to an electrode of said gas discharge lamp.

21. The trigger circuit of claim **19** further including a firing transformer wherein said silicon controlled recti-

fier is in a series loop connection with said trigger capacitor and the primary winding of said firing transformer, a winding of which is also connected to said gas discharge lamp so as to initiate a pulse discharge from the triggering of said silicon controlled rectifier.

22. Apparatus as recited in claim **19** further including means for preventing battery overcharge by limiting current through one of the electrical paths that connects to said battery.

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(54) **PORTABLE POWER SOURCE SYSTEM**

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(57) **ABSTRACT**

In a portable power source system comprising a battery pack for accommodating at least one secondary battery and a mounting part for mounting the battery pack, the mounting part is disposed in power using equipment, the battery pack comprises a charge circuit having a charge terminal and a discharge circuit having a discharge terminal, the charge circuit comprises a control circuit for controlling a voltage and a current during charging, the mounting part comprises a protruding external terminal for connecting with the discharge terminal, the battery pack comprises an inserting part for inserting the external terminal, the discharge terminal is disposed in a concealed position inside the inserting part, the battery pack is movable from an initial position to a fixing position while the external terminal has been inserted in the inserting part, and connection between the external terminal and the discharge terminal is achieved at the fixing position.

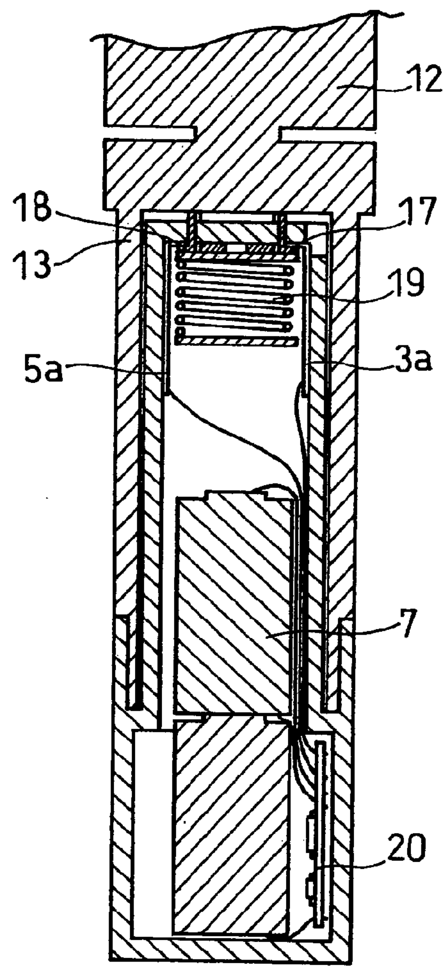


FIG. 1

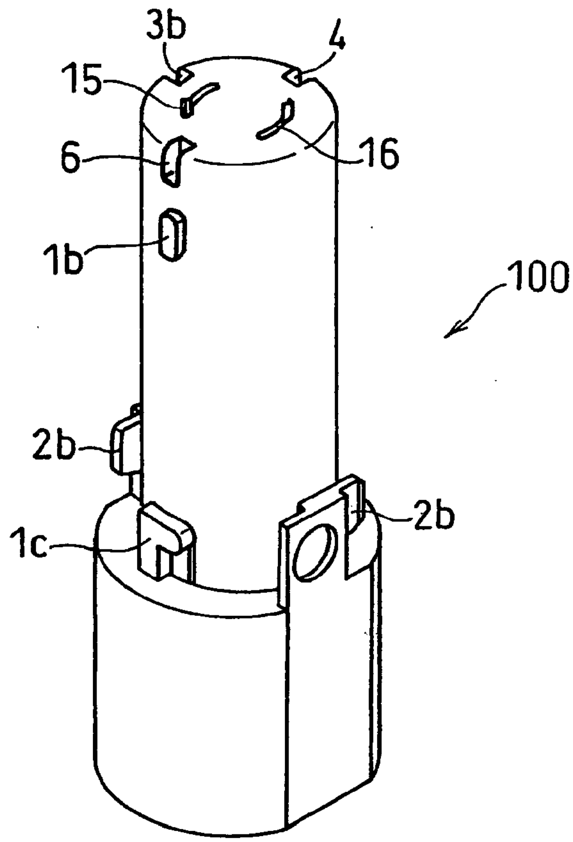


FIG. 2

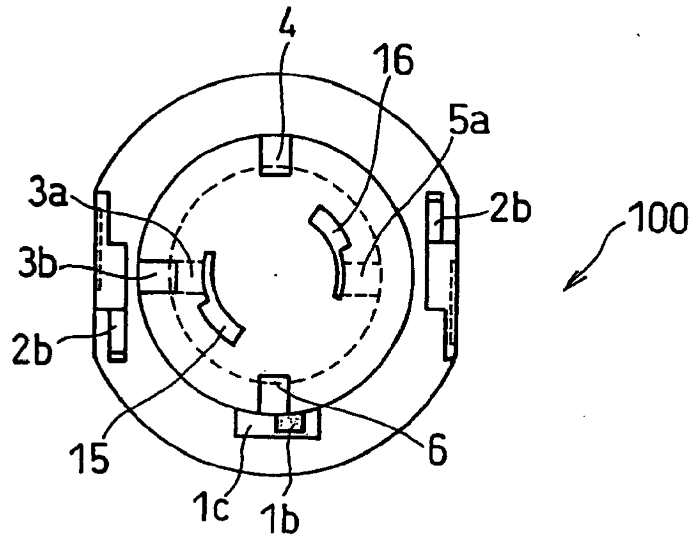


FIG. 3

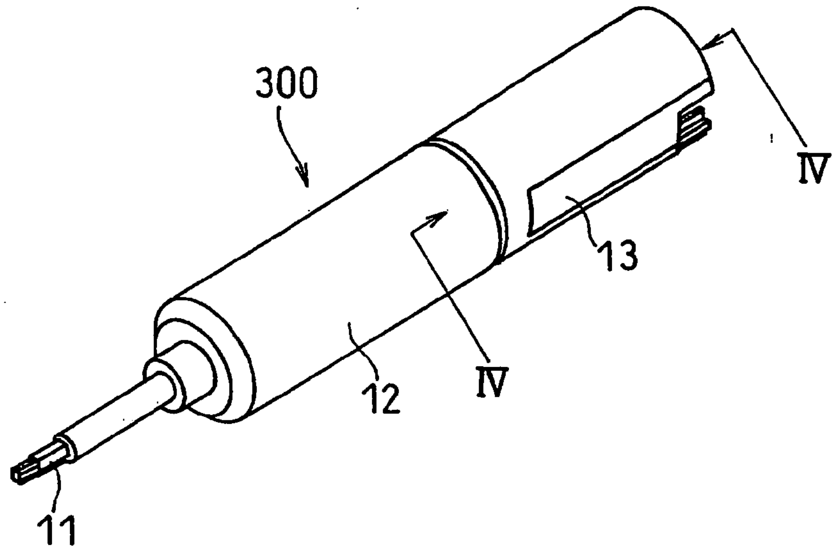


FIG. 4

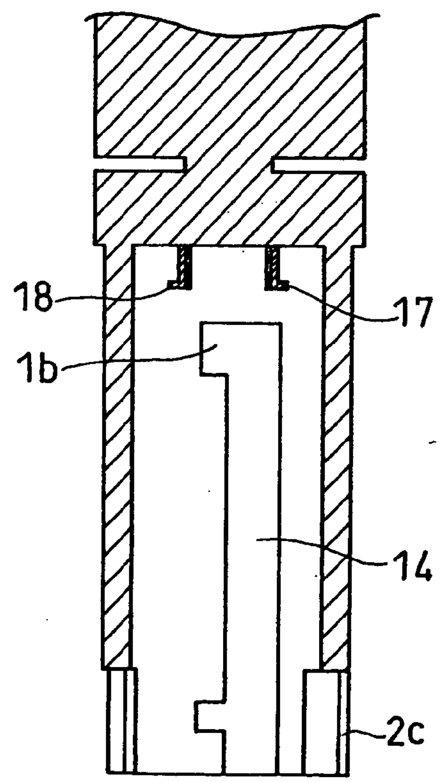
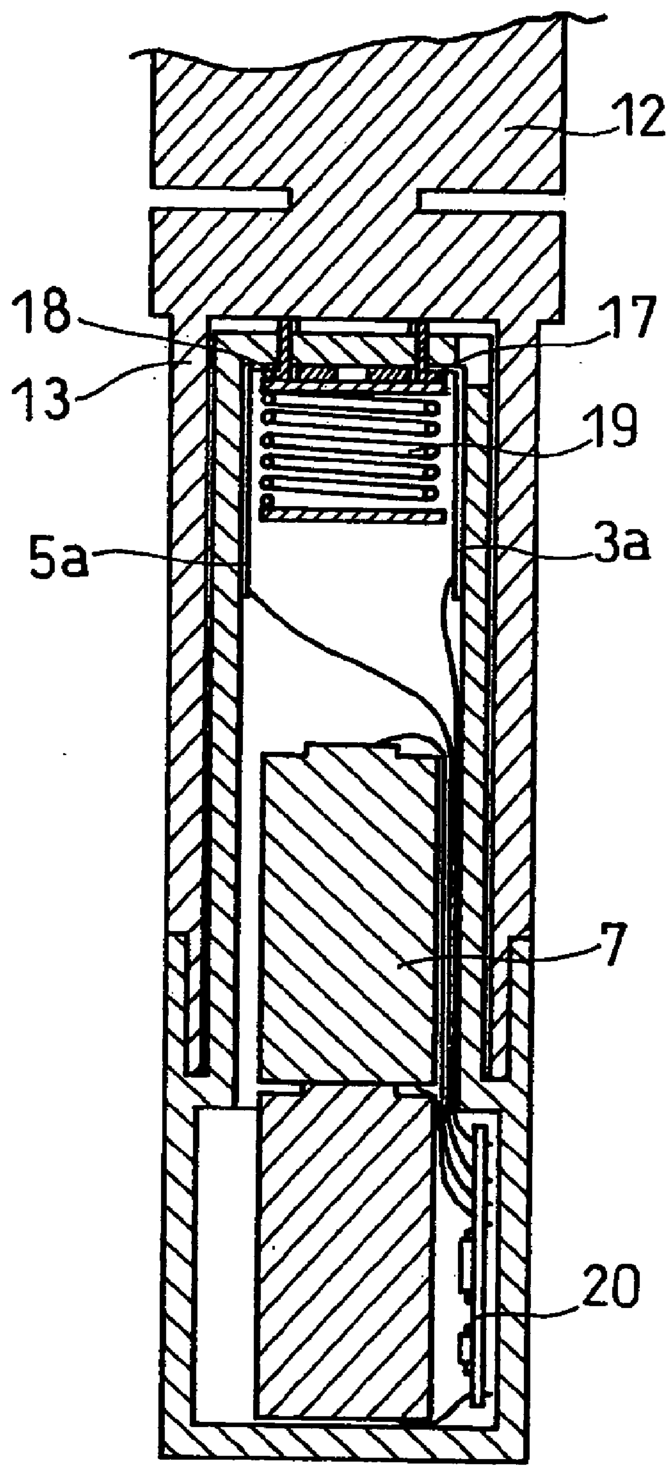
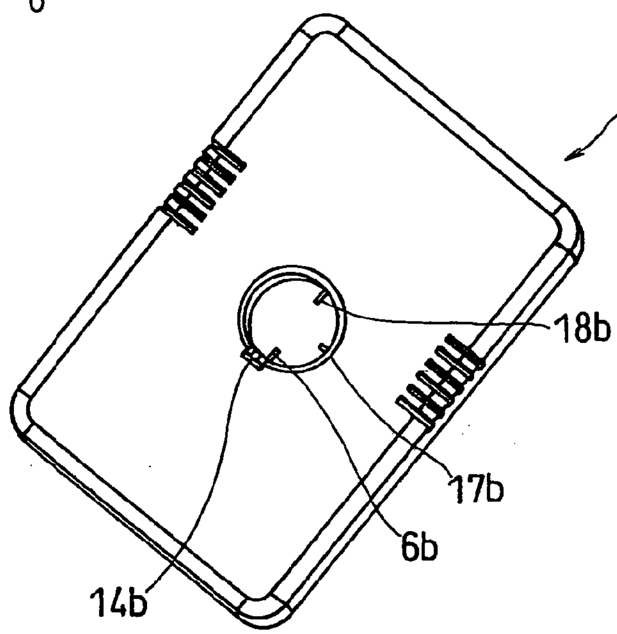


FIG. 5



F I G. 6



F I G. 7

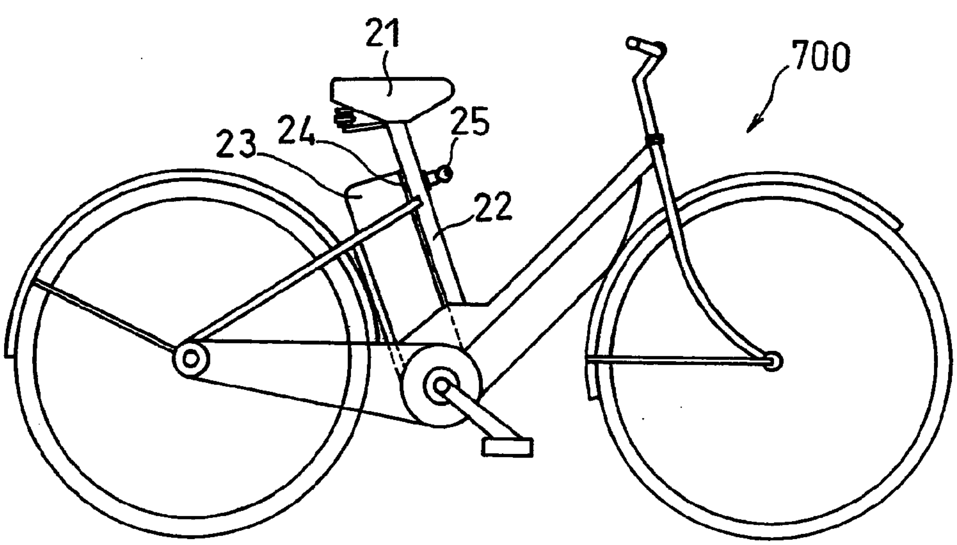
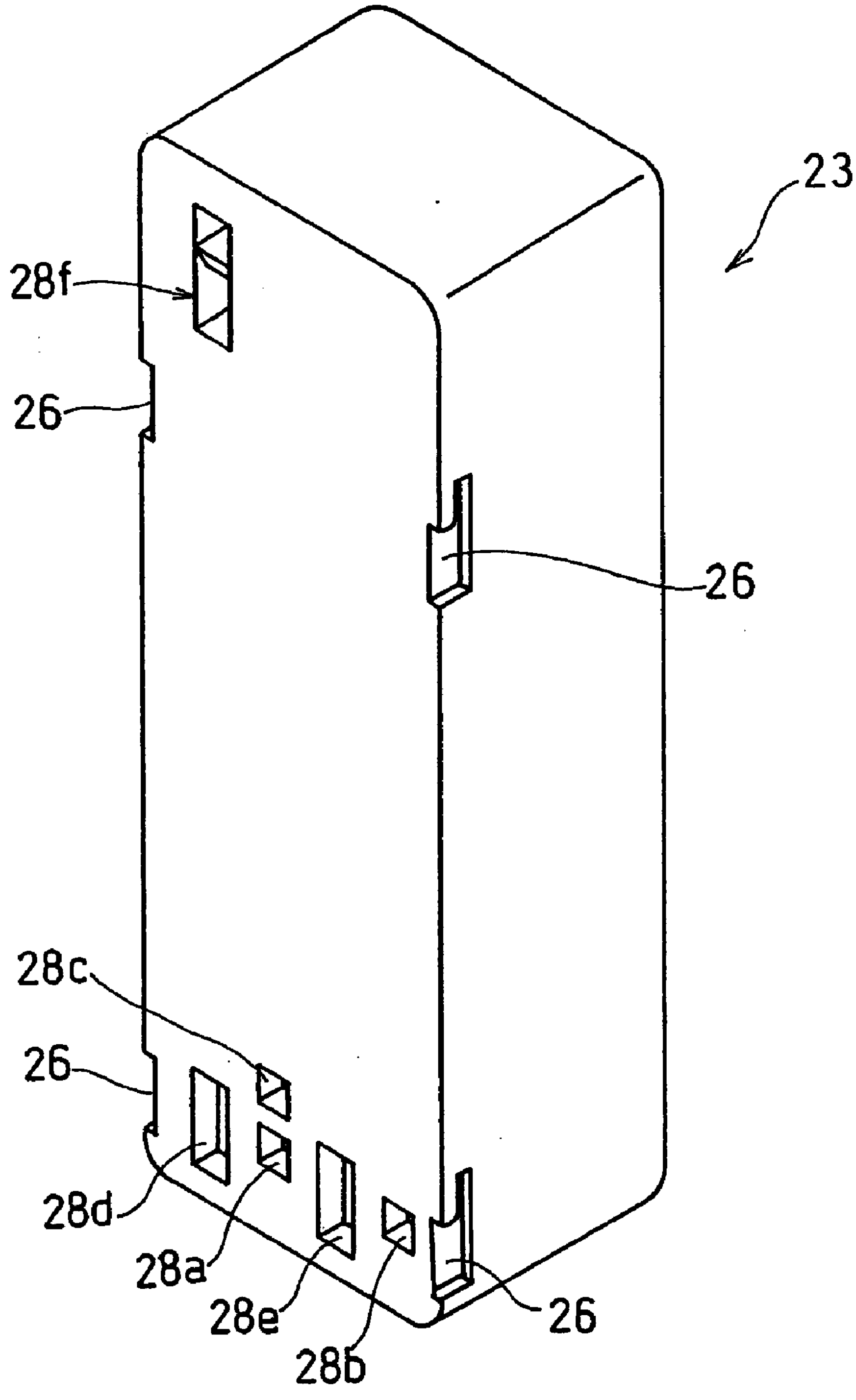


FIG. 8



F I G. 9

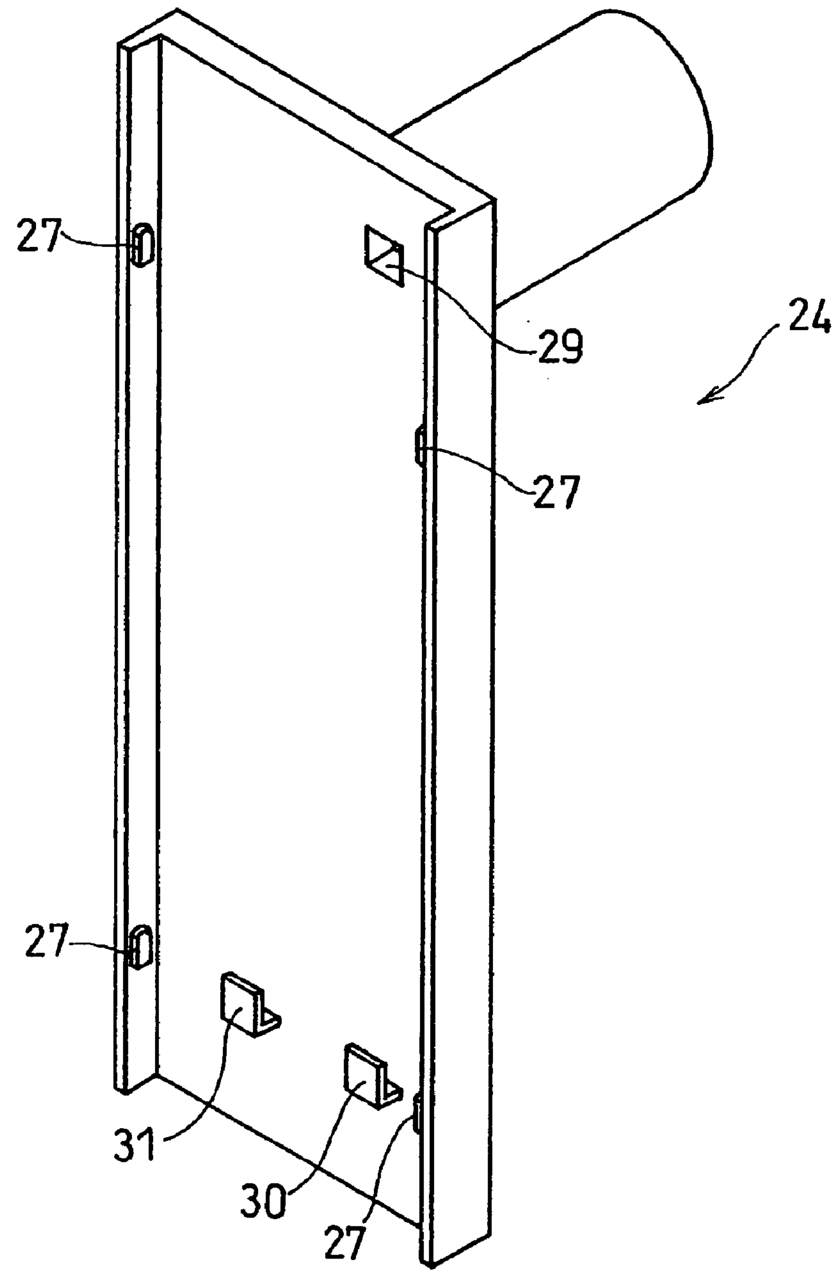


FIG. 10

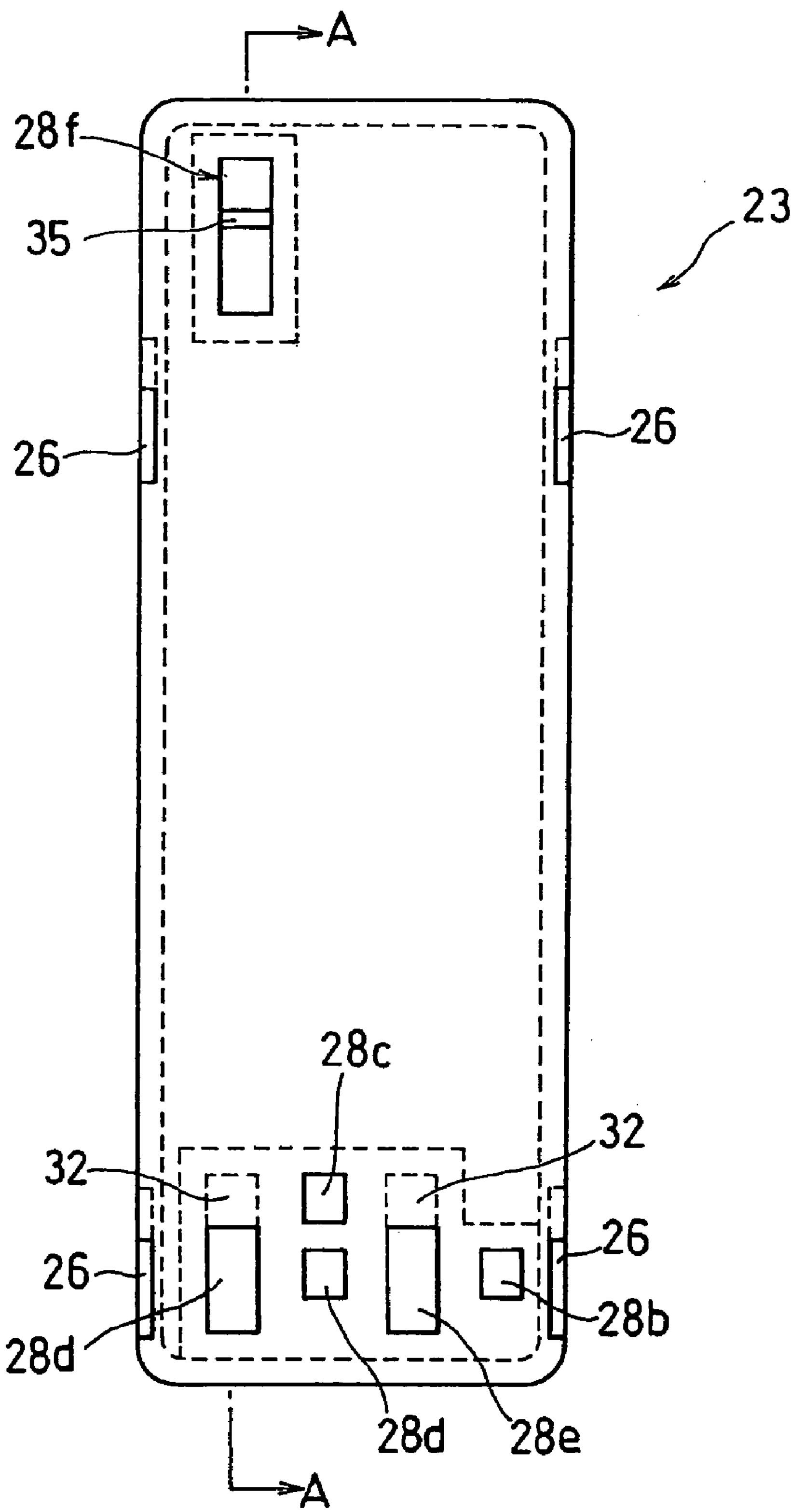


FIG. 11

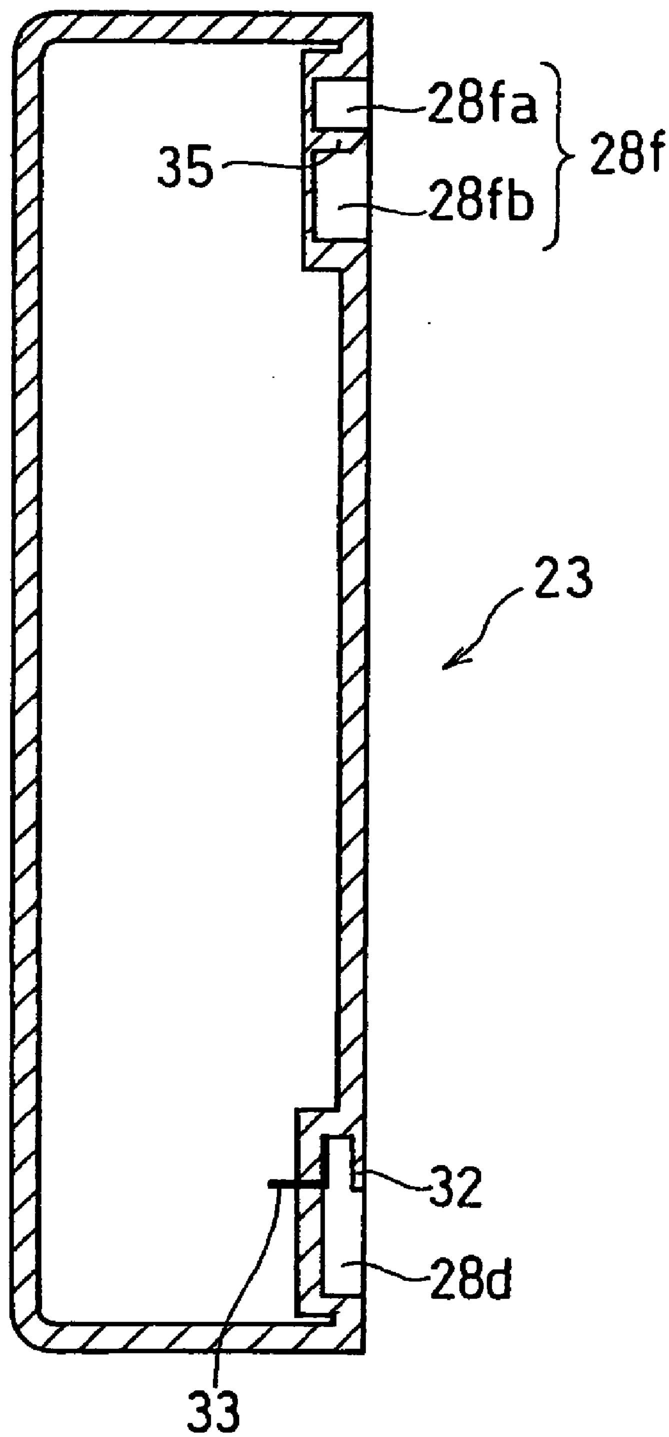


FIG. 12

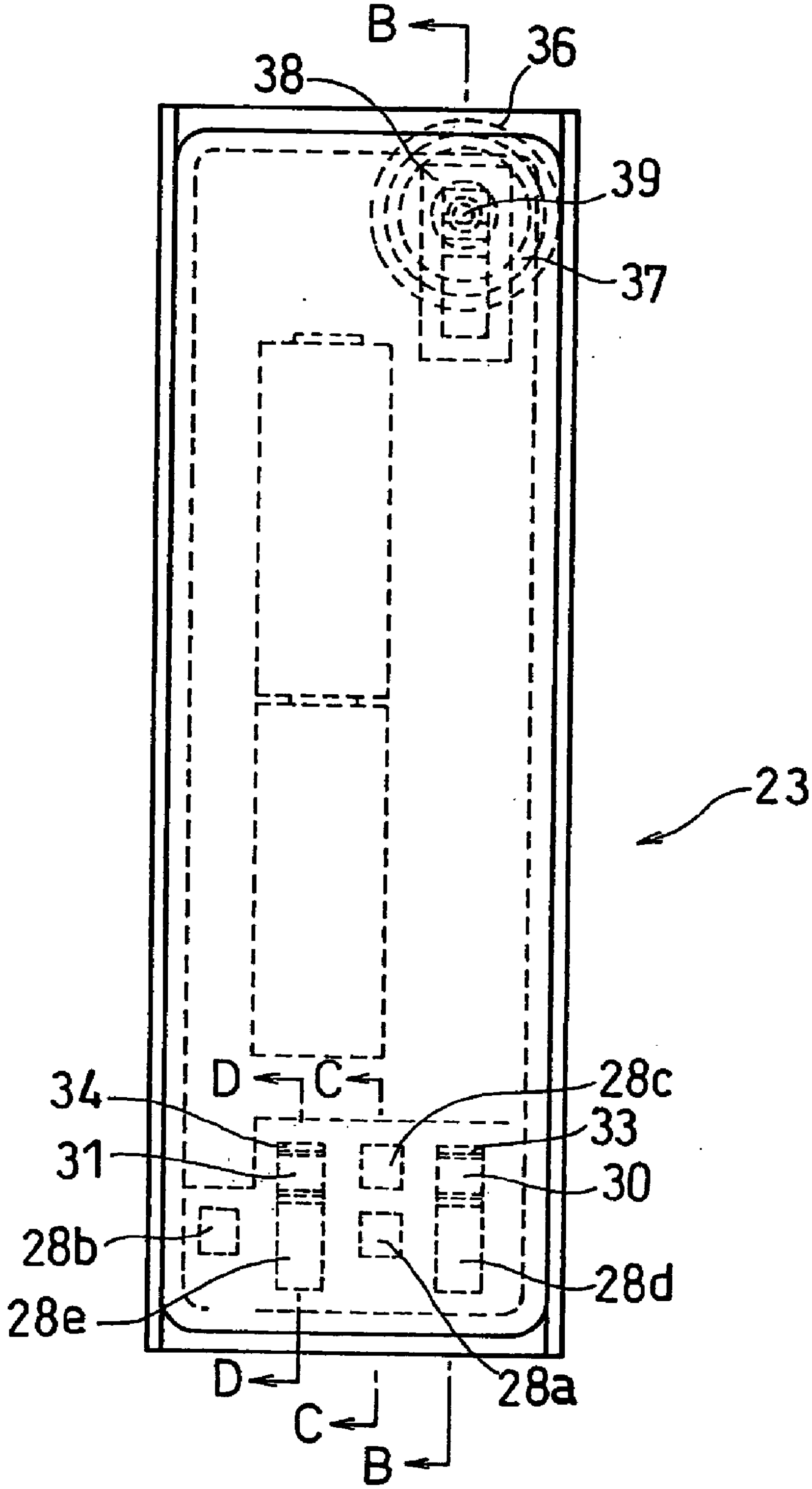
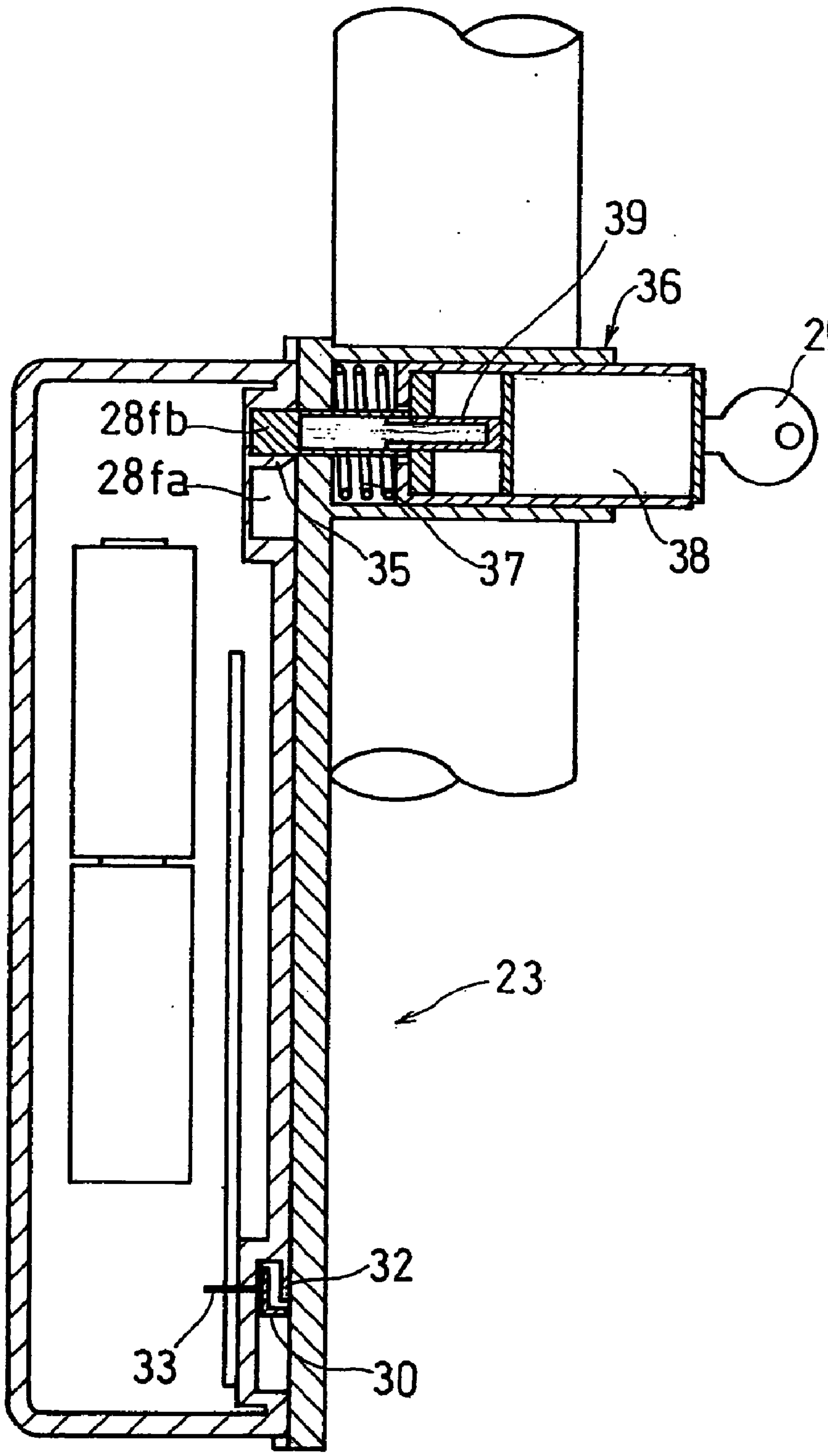
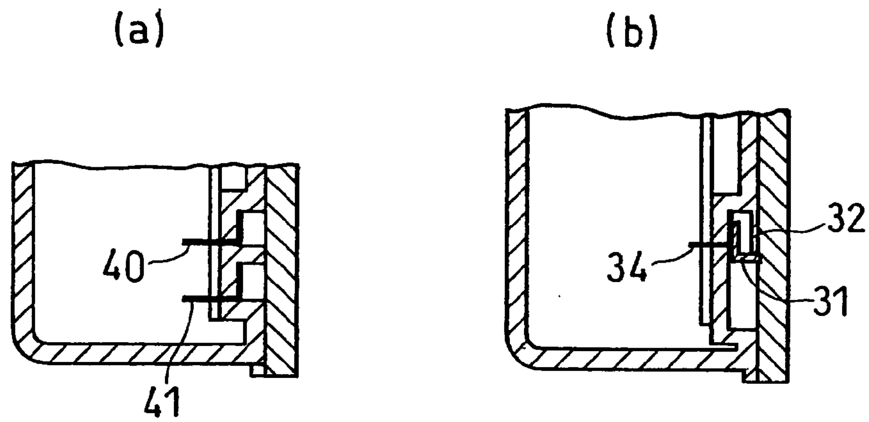


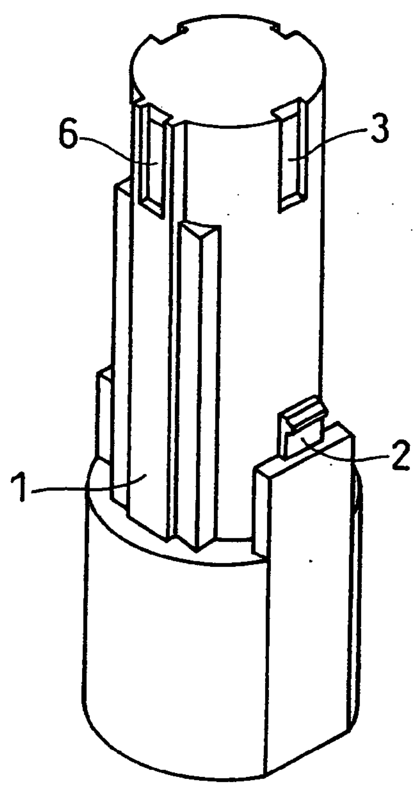
FIG. 13



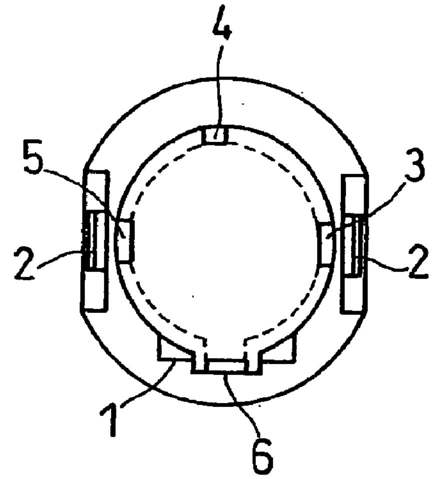
F I G. 1 4



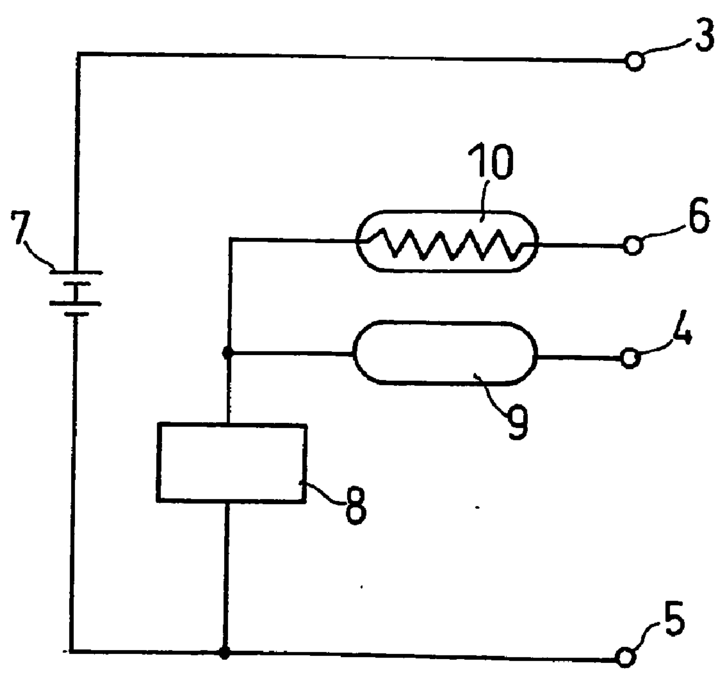
F I G. 1 5



F I G. 1 6



F I G. 1 7



PORTABLE POWER SOURCE SYSTEM

BACKGROUND OF THE INVENTION

[0001] As power using equipment which uses a portable power source system, there are for example electric tools such as electric screwdrivers for use in the screw fastening work. The use of electric tools can significantly improve work efficiency. While electric tools have recently been available at home improvement centers and the like and come to be used for do-it-yourself, they have been mainly used in construction sites and the like for business purpose.

[0002] There are however some cases where a construction site or the like is not wired. Further, the presence of cords or the like may negatively affect working performance. For this reason, a battery pack is employed in electric tools which operate at relatively low voltage, such as screwdrivers. A typical battery pack accommodates plural secondary batteries therein as a power source. Such a battery pack is detachable and, for conducting charging, it is inserted into a charger specific to the battery pack. On a construction site or the like, even when a battery is run down halfway through the work, preparation of a spare battery pack allows replacement of the battery pack and continuation of the work.

[0003] The battery pack (Model No. EZ9025) for the electric tool (DRILL & DRIVER, Model No. EZ6225) manufactured by Matsushita Electric Works, Ltd., one of the examples of the conventional battery packs, is described by reference to FIGS. **15** to **17**.

[0004] **FIG. 15** is an oblique view of the battery pack (EZ9025), and **FIG. 16** is a top plan view thereof. At the time of insertion of the battery pack into the electric tool, the battery pack is positioned by a guide **1** to be inserted, and then fixed to the electric tool with a latch **2**. On the upper end of the battery pack disposed while being exposed to the outside are a positive electrode terminal **3** both for charging and discharging, a charge negative electrode terminal **4** specifically for charging, a discharge negative electrode terminal **5** specifically for discharging, and a thermistor terminal **6**.

[0005] **FIG. 17** shows a circuit diagram of the battery pack (EZ9025). A discharge circuit comprising the positive electrode terminal **3**, a secondary battery **7** and the discharge negative electrode terminal **5** is not provided with a current regulating device, whereas a charge circuit comprising the positive electrode terminal **3**, the secondary battery **7** and the charge negative electrode **4** is provided with a control circuit **8** and a thermal protector **9**, securing safety during charging. Further, a thermistor **10** is connected to the thermistor terminal **6**. During charging, the temperature of the battery pack is monitored with resistance values of the thermistor **10** to control charging according to the monitored temperatures.

[0006] As thus described, the conventional battery pack comprises the current regulating device in the charge circuit. The current regulating device will prevent a current from continuing to flow in the battery pack if the charger should suffer a breakdown. However, the discharge circuit is not provided with a current regulating device because there are cases where a heavy current temporarily flows and a total amount of the discharge current is regulated by the capacity of the secondary battery.

[0007] In the conventional battery pack, it is possible to charge the battery pack by connection between the discharge terminal and a large-sized battery such as a battery for automobiles, since the discharge terminal is in a state of exposure to the outside. There however is a safety problem in charging by the use of the discharge terminal because of the absence of the current regulating device in the discharge circuit.

[0008] For the purpose of protecting terminals of a battery pack from shock caused by dropping and the like, there has been proposed a structure where an external terminal is provided on the inner circumferential side of a lid of a loop-shaped battery pack (Japanese Laid-Open Patent Publication No. 2001-135287). Also in this structure, however, the discharge terminal is in a state of exposure to the outside and the connection between the discharge terminal and the large-sized battery is therefore possible.

BRIEF SUMMARY OF THE INVENTION

[0009] The present invention was made in view of what were described above, and relates to a portable power system having a so-called double action system, particularly aiming at provision of a portable power source system where connection between a discharge terminal of a battery back and an external terminal is achieved only when power using equipment is used.

[0010] A portable power source system in accordance with the present invention comprises a battery pack for accommodating at least one secondary battery and a mounting part for mounting the battery pack. The battery pack is detachable from the mounting part and exchangeable with a spare battery pack. The mounting part is disposed in power using equipment.

[0011] The battery pack comprises a charge circuit having a charge terminal and a discharge circuit having a discharge terminal, and the charge circuit comprises a control circuit for controlling a voltage and a current during charging.

[0012] The mounting part comprises a protruding external terminal for connecting with the discharge terminal of the discharge circuit, the battery pack comprises an inserting part for inserting the external terminal, and the discharge terminal is disposed in a concealed position inside the inserting part.

[0013] The battery pack is movable from an initial position to a fixing position while the external terminal of the mounting part has been inserted in the inserting part, and connection between the discharge terminal of the discharge circuit and the external terminal is achieved at the fixing position.

[0014] Above mentioned "the discharge terminal is disposed in a concealed position" means that the discharge terminal of the discharge circuit and the external terminal are not mutually connected in the initial position immediately after the insertion of the external terminal of the mounting part into the inserting part. The connection between the external terminal and the discharge terminal requires rotation of the battery pack from the initial portion or sliding thereof in a direction different from the inserting direction. In such a structure, even when a lead wire or the like connected to a large-sized battery or the like is inserted into the inserting part, the lead wire cannot be connected to the

discharge terminal. Hence the act of charging from the discharge terminal is prevented to secure safety.

[0015] Each of the charge terminal and the discharge terminal can comprise both a positive electrode terminal and a negative electrode terminal. In this case, the negative electrode terminal of the charge circuit and the negative electrode terminal of the discharge circuit are mutually electrically independent whereas the positive electrode terminal of the charge circuit and the positive electrode terminal of the discharge circuit are united and can employ the structure having the equivalent potential. Such a structure enables reduction in production cost because the charge circuit and discharge circuit comprise the common positive electrode terminal. Further, there is an advantage in this structure that the lead wire to be led out from the secondary battery and the common positive electrode terminal of the charge circuit and the discharge circuit can be constituted by a single metal part.

[0016] As for the metal part used can be metal plate in the form of a strip with an L-shaped top. For example, part of the top of the metal plate is disposed in a concealed position to serve as the positive electrode terminal in the discharge circuit; any of the other parts of the metal plate is exposed to the outside to serve as the positive electrode terminal of the charge circuit.

[0017] It is preferable that the battery pack comprises a thermistor terminal for temperature measurement. When the battery pack comprises the thermistor terminal, it is possible to charge the battery while measuring the temperature of the battery pack during charging.

[0018] It is further preferable that the charge circuit comprises a thermal protector. As for the thermal protector used can be conventionally known ones such as a thermostat, a PTC device and a thermal fuse. In the case where the charge circuit comprises the thermal protector, high safety can be secured even when a lead wire or the like connected to a large-sized battery is connected to the charge circuit.

[0019] With the discharge terminal disposed in a concealed position, there is no need for the discharge circuit to comprise a current regulating device. In the conventional configuration, on the other hand, it is essential for securing safety that the discharge circuit comprise the current regulating device especially when the secondary battery is a lithium-ion secondary battery. It is greatly advantageous that the discharge circuit does not need to comprise the current regulating device.

[0020] As the charge circuit comprises at least the control circuit, the charge terminal is not required to be concealed but may be exposed to the outside. When the charge terminal is exposed to the outside, the external terminal of the charger and the charge terminal of the battery pack can be mutually connected by a single action, i.e. insertion.

[0021] The portable power source system in accordance with the present invention is effective especially when the secondary battery is a lithium-ion secondary battery. For, the lithium ion secondary battery in particular requires protection since it is weak against overcharge.

[0022] The portable power source system in accordance with the present invention is suitable for a power source system for use in electric tools, electric vacuum cleaners, electric bicycles or electric motorbikes.

[0023] While the novel features of the invention are set forth particularly in the appended claims, the invention, both as to organization and content, will be better understood and appreciated, along with other objects and features thereof, from the following detailed description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0024] **FIG. 1** is an oblique view of a battery pack in accordance with one embodiment of the present invention.

[0025] **FIG. 2** is a top plan view of the battery pack in accordance with one embodiment of the present invention.

[0026] **FIG. 3** is an oblique view of an electric tool in accordance with one embodiment of the present invention.

[0027] **FIG. 4** is a vertical sectional view of a mounting part of the battery pack in accordance with one embodiment of the present invention.

[0028] **FIG. 5** is a vertical sectional view of the mounting part of **FIG. 4**, to which the battery pack of **FIG. 1** has been connected.

[0029] **FIG. 6** is an oblique view of a charger of the battery pack in accordance with one embodiment of the present invention.

[0030] **FIG. 7** is a side view of an electric bicycle in accordance with another embodiment of the present invention.

[0031] **FIG. 8** is an oblique view of a battery pack in accordance with another embodiment of the present invention.

[0032] **FIG. 9** is an oblique view of a mounting part of the battery pack in accordance with another embodiment of the present invention.

[0033] **FIG. 10** is a rear view of the battery pack in accordance with another embodiment of the present invention.

[0034] **FIG. 11** is a sectional view on the line A-A of **FIG. 10**.

[0035] **FIG. 12** is a top plan view of the battery pack of **FIG. 8** connected to the mounting part of **FIG. 9**.

[0036] **FIG. 13** is a sectional view on the line B-B of **FIG. 12**.

[0037] **FIG. 14A** is a sectional view on the line C-C of **FIG. 12**.

[0038] **FIG. 14B** is a sectional view on the line D-D of **FIG. 12**.

[0039] **FIG. 15** is an oblique view of one example of conventional battery packs.

[0040] **FIG. 16** is a top plan view of one example of conventional battery packs.

[0041] **FIG. 17** is a circuit diagram of a conventional battery pack.

DETAILED DESCRIPTION OF THE INVENTION

[0042] Embodiment 1

[0043] In the following, a description is given by reference to the drawings.

[0044] In the present embodiment, a portable power source system having a double action system in which an external terminal provided on a mounting part of an electric screwdriver as power using equipment is inserted into an inserting part of a battery pack, and the battery pack is then rotated.

[0045] **FIG. 1** is an oblique view of the battery pack **100** in accordance with the present embodiment, and **FIG. 2** is a top plan view thereof. **FIG. 3** is an oblique view of the electric tool **300** in accordance with the present embodiment.

[0046] The electric tool **300** comprises a driver bit **11**, a driving part **12** and a battery pack mounting part **13**. Parts not directly concerned with the content of the present invention, such as an on/off switch and a selector switch, have been omitted from **FIG. 3**. **FIG. 4** is a vertical sectional view on the line IV-IV of the battery pack mounting part **13**.

[0047] **FIG. 5** is a vertical sectional view of the mounting part **13** to which the battery pack **100** has been connected. The battery pack **100** comprises guides **1***b* and **1***c* for protection against reverse connection, which serve to position the battery pack when connected. The guides **1***b* and **1***c* move parallel with a guide groove **14** of the mounting part **13** so that the operation of rotating the battery pack clockwise can certainly be carried out while the battery pack has been inserted into the mounting part **13**. A latch **2***b* is fitted in a latching groove **2***c* provided in the mounting part **13** by rotating the battery pack clockwise to a fixing position.

[0048] The top of the battery pack **100** is provided with a groove **15** for the positive electrode terminal and a groove **16** for the negative electrode terminal, of the discharge circuit, and a positive electrode terminal **3***a* and a negative electrode terminal **5***a*, made of a metal plate, of the discharge circuit are disposed in concealed positions inside the respective grooves.

[0049] The top of the battery pack **100** is also provided with a positive electrode terminal **3***b* and a negative electrode terminal **4**, of the charge circuit, which are in a state not concealed but exposed to the outside. The positive electrode terminal **3***b* of the charge circuit is united with the positive electrode terminal **3***a* of the discharge circuit and they have the equivalent potential.

[0050] The top of the battery pack **100** is further provided with a thermistor terminal **6** to form, together with a thermistor housed in the battery pack, such a circuit as shown in **FIG. 17**.

[0051] As shown in **FIG. 4, a** positive electrode terminal **17** and a negative electrode terminal **18**, of the mounting part **13**, are in L-shape and they are first inserted into the wider portions of the groove **15** for the positive electrode terminal and the groove **16** for the negative electrode terminal, of the discharge circuit, respectively. They then move to the narrower portions by rotation of the battery pack, and the curved tips of the positive electrode terminal **17** and the negative electrode terminal **18** are connected, respectively, to the positive electrode terminal **3***a* and the negative electrode terminal **5***a*, of the discharge circuit, disposed in concealed positions, as shown in **FIG. 5**. A spring **19** is built into the battery pack, and the spring **19** can prevent failure of the aforesaid connection by pressing those terminals.

[0052] The battery pack **100** houses, in addition to a secondary battery **7**, a control circuit, a thermistor and a thermal protector. An internal circuit including those parts is placed on a print substrate **20**. The wiring of the internal circuit is the same as that of the conventional battery pack shown in **FIG. 17**.

[0053] As obvious from **FIG. 2**, in the portable power source system in accordance with the present embodiment, even when the lead wires or the like connected to a large-sized battery or the like are inserted into the groove **15** for the positive electrode terminal and the groove **16** for the negative electrode terminal, those lead wires cannot be connected to the positive electrode terminal **3***a* and negative electrode terminal **5***a* of the discharge circuit because of complete concealment of the terminals **3***a* and **5***a* from the outside. The act of charging from the discharge terminal is therefore prevented, to secure safety.

[0054] **FIG. 6** shows an oblique view of a charger **600** for the battery pack **100**. Parts not directly concerned with the content of the present invention, such as an on/off switch and a charged-state indication light, have been omitted from **FIG. 6**.

[0055] The charger **600** comprises a positive electrode terminal **17***b*, a negative electrode terminal **18***b*, a thermistor terminal **6***b* and a guide groove **14***b*. Prescribed terminals of the battery pack **100** are respectively connected to prescribed terminals of the charger **600** by fitting of the guide **1***b* of the battery pack **100** into the guide groove **14***b* of the charger **600**. That is, when charging is conducted with the charger, the terminals of the battery pack and those of the charger can be mutually connected by the single action of inserting the battery pack into the charger, which can be readily operated.

[0056] It is to be noted that, although the electric tool was exemplified in the present embodiment, the types of the power using equipment are not particularly limited. Further, the similar power source system is suitable especially for electric vacuum cleaners and the like.

[0057] Embodiment 2

[0058] Below, a description is given by reference to the drawings.

[0059] In the present embodiment described is a portable power source system having a double action system where an external terminal provided on a mounting part of an electric bicycle as power using equipment is inserted into an inserting part of a battery pack, and the battery pack is then slid in a direction perpendicular to the inserting direction.

[0060] **FIG. 7** is a side view of the electric bicycle **700** in accordance with the present embodiment. A mounting part **24** of a battery pack **23** is disposed on the back of a sheet tube **22** supporting a saddle **21**. An antitheft key **25** is used for detachment of the battery pack **23**.

[0061] **FIG. 8** is an oblique view of the battery pack **23** in accordance with the present embodiment, and **FIG. 9** is an

oblique view of the mounting part **24**. A guide groove **26** is provided in each long side face of the battery pack **23**, and guides **27** to be fitted in the guide grooves **26** are disposed on the mounting part **24**.

[0062] For the disposition of the battery pack **23** on the mounting part **24**, the battery pack **23**, positioned by the guide grooves **26** and the guides **27**, is first shifted vertically to the mounting face of the mounting part **24**. Thereafter, the battery pack **23** is slid in parallel with the mounting face to a fixing position.

[0063] In the lower part of the back face of the battery pack **23** provided are: a concave part **28***a* for a positive electrode terminal, a concave part **28***b* for a negative electrode terminal, of a charge circuit, a concave part **28***c* for a thermistor terminal, and a concave part **28***d* for a positive electrode terminal and a concave part **28***e* for a negative electrode terminal, of a discharge circuit. Further, in the upper part of the back face of the battery pack **23** provided is a locking concave part **28***f*.

[0064] On the mounting face of the mounting part **24**, a positive electrode terminal **30** and a negative electrode terminal **31**, both in L-shape, are provided in a position opposed to the concave part **28***d* for the positive electrode terminal and to the concave part **28***e* for the negative electrode terminal, respectively. Further, on the mounting face, a hook window **29** is provided in a position opposed to the locking concave part **28***f*. On the respective concave faces of the concave part **28***a* for the positive electrode terminal and the concave part **28***b* for the negative electrode terminal, of the charge circuit, as well as the concave face of the concave part **28***c* for the thermistor terminal, the respective terminals are exposed.

[0065] **FIG. 10** is a back view of the battery pack **23** of the present embodiment, and **FIG. 11** is a sectional view on the line A-A of **FIG. 10**. A blind plate **32** is provided each on the concave part **28***d* for the positive electrode terminal and the concave part **28***e* for the negative electrode terminal, of the discharge circuit. The positive electrode terminal **33** and the negative electrode terminal **34**, of the discharge circuit, are concealed by the blind plate **32**. The locking concave part **28***f* is divided by a partition **35** into two concave parts **28***fa* and **28***fb*.

[0066] **FIG. 12** shows a top plan view of the battery pack **23** connected to the mounting part **24**. Although the guides **27** are fitted in the guide grooves **26** when the battery pack is in a state shown in **FIG. 12**, they have been omitted from **FIG. 12**. **FIG. 13** is a sectional view on the line B-B of **FIG. 12**, **FIG. 14A** is a sectional view on the line C-C of **FIG. 12**, and **FIG. 14B** is a sectional view on the line D-D of **FIG. 12**.

[0067] In **FIG. 13, a** locking system part **36** comprises a hook **39** and a cylinder **38** supported by a spring **37**. The hook **39**, initially fitted in the concave part **28***fa*, is shifted over the partition **35** into the concave part **28***fb* by sliding of the battery pack **23** in parallel with the mounting face of the mounting part **24** from an initial position to a fixing position. Thereat, locking with the key **25** becomes possible.

[0068] In the initial position where the hook **39** is in a state of fitting in the concave part **28***fa*, the positive electrode terminal **33** and the negative electrode terminal **34**, of the discharge circuit, provided in the battery pack **23**, are not connected respectively to the positive electrode terminal **30** and the negative electrode terminal **31**, of the mounting part **24**. These terminals of the discharge circuit and the mounting part **24** are mutually connected by the sliding of the battery pack thereafter. As shown in **FIG. 14**A, on the other hand, a thermistor terminal **40**, a positive electrode terminal **41** of the charge circuit and the like, to be used during charging, are closed with a lid.

[0069] Also in the present embodiment, the positive electrode terminal **33** and the negative electrode terminal **34**, of the discharge circuit, are disposed in a position concealed by the blind plate **32**, as evident from **FIGS. 13 and 14**B. Even with insertion of lead wires or the like connected to a large-sized battery or the like into the concave part **28***d* for the positive electrode terminal and the concave part **28***e* for the negative electrode terminal, therefore, the lead wires can be connected to neither the terminals **33** nor **34**. Hence the act of charging from the discharge terminal is prevented so as to secure safety.

[0070] It should be noted that, although the electric bicycle was exemplified in the present embodiment, the types of the power using equipment are not particularly limited. Further, the similar power source system is suitable especially for electric motorbikes.

[0071] As thus described, according to a portable power source system of the present invention, the discharge terminal is disposed in a concealed portion to enable the connection between the discharge terminal and the external terminal by a double action system so that high safety can be secured with a simple structure.

[0072] Although the present invention has been described in terms of the presently preferred embodiments, it is to be understood that such disclosure is not to be interpreted as limiting. Various alterations and modifications will no doubt become apparent to those skilled in the art to which the present invention pertains, after having read the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and modifications as fall within the true spirit and scope of the invention.

1. A portable power source system comprising a battery pack for accommodating at least one secondary battery and a mounting part for mounting said battery pack,

said mounting part being disposed in power using equipment,

said battery pack comprising a charge circuit having a charge terminal and a discharge circuit having a discharge terminal, and said charge circuit comprising a control circuit for controlling a voltage and a current during charging,

said mounting part comprising a protruding external terminal for connecting with said discharge terminal, said battery pack comprising an inserting part for inserting said external terminal, and said discharge terminal being disposed in a concealed position inside said inserting part,

said battery pack being movable from an initial position to a fixing position while said external terminal has been inserted in said inserting part, and connection

between said external terminal and said discharge terminal being achieved at said fixing position.

2. The portable power source system in accordance with claim 1, wherein said charge terminal and discharge terminal respectively comprise both a positive electrode terminal and a negative electrode terminal, and said negative electrode terminals are mutually electrically independent while said positive electrode terminals are united and have equivalent potential.

3. The portable power source system in accordance with claim 1, wherein said battery pack comprises a thermistor terminal for temperature measurement.

4. The portable power source system in accordance with claim 1, wherein said charge circuit further comprises a thermal protector.

5. The portable power source system in accordance with claim 1, wherein said discharge circuit does not comprise a current regulating device.

6. The portable power source system in accordance with claim 1, wherein said charge terminal is not concealed but exposed to the outside.

7. The portable power source system in accordance with claim 1, wherein said secondary battery is a lithium-ion secondary battery.

8. The portable power source system in accordance with claim 1, wherein said power using equipment is an electric tool, an electric vacuum cleaner, an electric bicycle or an electric motorbike.

* * * * *

X. RELATED PROCEEDINGS APPENDIX

None